PRACTICAL PATHOLOGY

INCLUDING MORBID ANATOMY AND POST-MORTEM TECHNIQUE

1 Cut surface of liver from case of pernicious anæmia showing brown coloration from excessive deposit of hæmosiderin Part has been treated with hydrochloric acid and ferrocyanide of potassium and shows the Prussian blue reaction

2 Cut surface of liver showing extreme fatty change.

3 Section of liver from case of jaundice showing green coloration of the organ Nodules of secondary carcinoma are also to be seen

4 Cut surface of waxy liver the greater part of which has been treated with iodine the waxy material giving a dark brown colour with the reagent

5 Section of liver showing early chronic venous congestion

6 Section of waxy kidney part of which has been treated with iodine

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AND

POST-MORTEM TECHNIQUE

BY

JAMES MILLER

M.D., D.Sc., F.R.C.P.E., F.R.S.C.

PROFESSOR OF PATHOLOGY, QUEEN'S UNIVERSITY, CANADA, BACTERIO-
LOGIST TO THE ONTARIO BOARD OF HEALTH; LATE LECTURER ON
MORBID ANATOMY, UNIVERSITY OF EDINBURGH   LECTURER ON
PATHOLOGY AND BACTERIOLOGY, SCHOOL OF MEDICINE OF THE ROYAL
COLLEGES, EDINBURGH, AND EDINBURGH SCHOOL OF MEDICINE FOR
WOMEN; EXAMINER IN PATHOLOGY UNIVERSITY OF ABERDEEN,
ROYAL COLLEGE OF PHYSICIANS EDINBURGH, AND BIRMINGHAM
UNIVERSITY, ETC.

PREFACE TO SECOND EDITION

IN preparing a second edition of this work the author, while bringing the subject matter up to date, has endeavoured to keep in mind the original object of the book, namely, the preparation of a handy volume for the use of the junior student in the post mortem room, practical class, and museum. The book in no way attempts to supplant the larger text books and is not intended for the advanced student. Several portions, e g those dealing with the endocrine organs, appendicitis, and nephritis, have been enlarged and practically rewritten

It is always a difficult matter in preparing subsequent editions to retain the proper balance of a book In deciding the emphasis to be laid upon the commoner as compared with the rarer diseases the author has perforce to fall back upon his own experience But there is no other criterion to go upon, if the book is to have that personal touch which is so necessary

The author is indebted to Dr F J Browne of Edinburgh for writing the sections dealing with post mortem examination of the fœtus and the new born child—sections which have added materially to the value of the book, to Dr L J Austin, F R C S, for rewriting the note on Medico-Legal points in relation to post mortems in England, also to Dr W D. Hay and Miss E Bickham for correcting proof and revising the index

PREFACE

THE object of this volume is to give the student of medicine
and the practitioner, in a handy form, the information
required for practical work in relation to Pathology   There
will be found short descriptions of the appearances in the
more common morbid processes to be met with in the
organs and tissues, at the same time these are co related
with the changes in the other organs and tissues of the body
in the various diseases   The main points in the microscopic
appearances are also given very shortly, merely in order to
remind the student what he should look for when going over
his slides   In dealing with post mortem technique, fixing
and mounting of preparations, cutting and staining of
sections, the endeavour has been to give one reliable method
in every case, rather than numerous alternative methods
Hence the book is not one for the specialist   The chapter
on Tumours is added to supplement the necessarily short
descriptions of neoplasms under the heading of the various
organs   For the benefit of the practitioner, a short chapter
dealing with the medico-legal aspects of post mortem work
has been included   Owing to the frequent occurrence of
cross references, it was decided to bind the illustrations
together in the form of an atlas at the end of the book
Illustrations of microscopic preparations have been omitted,
as the student has his slides to which he can refer

The author has made extensive use of volumes such as Sims
Woodhead's *Practical Pathology*, Shennan's *Post Mortems
and Morbid Anatomy*, Orth's *Pathologisch anatomische
Diagnostik and Erlauterungen zu den Vorschriften fur das
Verfahren der Gerichtsarzte bei den gerichtlichen Untersuchungen
menschlicher Leichen*, Herxheimer's *Grundriss der patho*

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logischen Anatomie and *Technik der pathologisch histologischer Untersuchung*, Manns *Physiological Histology*, Mallory and Wrights *Pathological Technique*, Letulles *La Pratique des autopsies* Adami s various works, Beattie and Dickson s *Pathology*, Pembrey and Ritchie s *General Pathology*, also Lorrain Smith and Mair s classical work on staining methods for fats in the *Journal of Pathology and Bacteriology*

To the personal teaching of Professors Greenfield, Muir, and Leith, and of the late Professors Ziegler and Weigert, a deep debt of gratitude is also due

The author has great pleasure in expressing his indebtedness to Professor Harvey Littlejohn for invaluable help in preparing the chapter on medico-legal post mortems and for his permission to use two typical post mortem reports His thanks are also due to Dr John Fraser for revising the chapter on diseases of bones, to Dr James Young for many suggestions in Chapter XII, to Dr W G Porter for assistance in preparing Figure 12, to Dr Sidney Smith for the use of his fine preparations illustrating centres of ossification in the infant in connection with the table on p 309, also to Mr W. Waldie of the Royal College of Surgeons' Museum Edinburgh, for his advice as to the fixing and mounting of specimens

The illustrations have, with one or two exceptions, been made by Mr Glass from preparations in the author's collection For the care and trouble taken, the author wishes to express his hearty thanks If acknowledgment has not in every instance been made to the physician or surgeon who had charge of the case, the author begs to offer his apologies His thanks are due to Professor Sutherland for the specimen from which Fig 33 was drawn

For much useful advice and criticism I have to thank the Editor of the *Edinburgh Medical Series*—Dr J D Comrie For reading the proofs and for drawing up the index I have to express my hearty thanks to my assistant, Dr Fergus Hewat.

J M

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CHAPTER I

INTRODUCTORY

THE post mortem examination, sectio cadaveris, or autopsy
is an essential part of the scientific investigation of all fatal
cases of disease   It is obvious that only by its means can
the medical man acquire an accurate knowledge of the nature,
extent, distribution, and complications of a morbid condition
It is not too much to say that however plain and simple the
diagnosis of a disease may be, some additional light will be
thrown upon the case at the post mortem examination   In
a very considerable number of instances, conditions quite
unexpected during life will be found, and, in a few, the
diagnosis of the clinician will be entirely upset by the patholo-
gist's investigations

A post mortem examination should therefore be performed
whenever feasible   Further, the examination should be as
thorough as possible   should, in other words, include as
many parts of the body as possible, and should be followed
by microscopic, and, if necessary, bacteriological examination
of the diseased organs and tissues   In not a few instances
the pathologist's view of a case obtained by naked-eye

examination alone is greatly altered by subsequent micro-scopic or bacteriological investigation

For example, in a case which came under the author's *notice there was a stricture of the small intestines which,* from the clinical history as well as from the naked-eye appear ances, was believed to be malignant. Microscopic examina tion showed the condition to be tuberculous.

In another case, where hæmorrhagic infiltration of the mediastinal tissues was the main post mortem finding, the true nature of the disease was only found on making cultures, when a pure growth of the anthrax bacillus was obtained, the case proving to be one of "woolsorter's disease."

From another point of view a post mortem examination may be required, that is the medico-legal   Cases of suspected poisoning may prove to be ordinary diseased conditions, and, *vice versa,* cases where foul play is unsuspected may turn out to be due to poisoning

To give another example from the author's experience A well to do contractor died suddenly with symptoms of severe jaundice   His will was known to be drawn out in favour of the foreman of his works, with whom he lived   The medical attendant considered phosphorous poisoning a possi bility, but post mortem examination revealed the presence of a large impacted calculus in the common bile duct.

In all cases of sudden death where the cause is unknown, or of violent or suspected violent deaths, notice must be sent at once to the Procurator Fiscal or Coroner   Such bodies become the property of the Fiscal or Coroner, and cannot be touched without his consent   (For further information on this point see Chapter XV)

Precautions to be taken.—Before proceeding in any way to carry out a post mortem examination, it is absolutely necessary that the permission of the nearest relative of the deceased be obtained   In certain hospitals, more happily situated than their fellows, the regulation is, that unless

notice to the contrary be received from the relatives within twenty four hours of the death of the patient, an autopsy will be performed This is a far better system than the one under which permission has to be asked for in each case When not confronted with the choice, the relatives, as a rule, except in the case of certain religious creeds, think little of the matter When permission is asked for, they at once begin to conjure up visions of mutilation, and it requires in most instances no little tact on the part of the medical man to obtain permission In every case, however, where leave has to be asked, it should be obtained *in writing* from the *nearest relative* The absolute necessity for this precaution, if the doctor is to protect himself, has been emphasised on several occasions recently in the law courts In a case tried before the Court of Session in Edinburgh, the judge, in charging the jury, said that the holding of an unauthorised post mortem ' gave a legal remedy,' and that when per formed without consent " the case would be treated very smartly ", further, the defender, a medical man who had performed the sectio, " would have been well advised had he obtained permission from the father *in writing* '

Medico legal Cases —When the case is a medico-legal one, it is necessary to receive permission from the Procurator-Fiscal (Scotland) or the Coroner (England) before a post mortem examination is performed This permission having been obtained, none other is required Although in all cases it is advisable to take full notes at the time, these should be taken with special care in cases which have, or are likely to have, a medico-legal aspect (*e g* workmen s compensation cases)

In certain cases with a medico-legal aspect the Coroner or Fiscal will order an autopsy to be performed When reporting such a case the pathologist should avoid as far as possible the use of technical terms In Scotland such a

report requires to be drawn up in what is known as the "soul and conscience form' (see Chapter XV)

Importance of Post-mortem Change —It is quite obvious that the sooner the post mortem examination is carried out after the death of the patient the better, but unless there is any special reason to the contrary it is usual to wait for twenty four hours

The changes which begin to take place in a body after death tend to mask, and eventually to obliterate entirely, the characteristic appearances of most pathological conditions Diseased conditions have been found in Egyptian mummies, and caries of teeth and evidence of rickets in the skeletons of prehistoric men, but *as a rule the softer parts, and more particularly the hollow viscera and abdominal organs, rapidly lose the characteristic signs of disease through decomposition* The extent and rapidity of this change will, of course, depend upon circumstances The processes take place much more rapidly in warm weather Conversely in cold weather, or if, as is possible in some hospitals, the bodies are placed in an apparatus artificially cooled, they will retain their freshness for a much longer period Another factor bearing upon this is the disease from which the patient has died In septic conditions, more particularly in the abdominal cavity, decomposition occurs more quickly, and tends to alter the appearance of organs in the neighbourhood.

Furthermore *when preservatives have been injected into the cavities of the body as is often the case in America, due allowance has to be made for the effects of strong formalin on the viscera*

CHAPTER II

Rubber Gloves —One of the most important parts of the pathologist's equipment is a good, sound pair of rubber gloves   Fifteen or twenty years ago gloves were seldom worn   In consequence, those carrying out post mortem work suffered periodically from septic wounds, if not from the more serious infections, such as tuberculosis   Nowadays there is no excuse for such accidents, as gloves are cheap, and with care they last a considerable time   The best type of glove is the thin rubber glove used by the surgeon   The thicker ones naturally last longer, but they are more expensive, more difficult to work with, and are more troublesome to mend

It is very necessary that the pathologist should care for his gloves, seeing so much depends upon them   During a post mortem the gloves should be frequently washed under running water to prevent the drying of blood or pus upon their surface   After the operation is finished, they should be washed while on the hands, first with soap and water, and then with water alone, afterwards dried, and while still on the hands moistened all over with biniodide of mercury spirit (biniodide of mercury 1 part, methylated spirit 500) and dried again with a towel   If punctured, the

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interior of the glove should, of course, be similarly treated
The exact position of a puncture can be found by distending
the glove with water.   A patch can then be applied, just as
one mends a punctured tyre   The gloves should subsequently
be folded up and placed in the cardboard box supplied with
them

If long intervals elapse between post mortems, the gloves
may become hard and brittle   A few minutes' immersion in
hot water will make them soft again.

Where gloves are not obtainable, the hands may be smeared
with carbolic oil

Post-mortem Wounds —In the case of a punctured
wound obtained at a post mortem it is well to wash the part
thoroughly in warm water, suck it, and then dress it with
some weak antiseptic, such as 1 40 carbolic.   Some recom
mend the use of pure carbolic or other strong acid in the
first instance   If slight, the wound can be covered with a
layer of celloidin dissolved in equal parts of alcohol and
ether, or with " new skin "

In his movements with knife or needle, the pathologist
should always be slow and cautious   When dealing with
purulent or other infective fluid, or with fæcal material,
great care should be taken *not to splash it about*   Severe
eye infections sometimes result in this way, and the author
knows of cases in which typhoid infection resulted from the
splashing of infected fæces   For this reason it is well to
avoid using a strong stream of water when washing intestines,
or, indeed, at any time

Eye Infections — When some foreign material has
entered the eye, the conjunctival sac should be washed out
with a little warm saline   The method of washing out is to
place the individual on a chair with head well thrown back,
and to squeeze the saline fluid into the eye with a piece of
cotton wool   There is no need to use an antiseptic, as the

conjunctival sac can of itself destroy a considerable amount
of infective material   The object of the washing is merely
to remove as much of the irritant as possible   In any case
the eye should not be rubbed or irritated in any way

Another source of danger for the pathologist is flies
These are excessively troublesome in warm climates, and are,
undoubtedly, a means of conveying infection   Fly papers
will be found useful in reducing the number

Turning to the question of instruments, these need not be
numerous or elaborate   The following are essential —

Instruments —1 *A sharp large-bladed knife* for making
incisions in the skin and for removing organs   Several of
these should be kept

2 *A long flat knife* for cutting into the solid organs

3 *A straight probe pointed bistoury* for opening the heart,
the smaller vessels, such as the coronary arteries for opening
the bronchi, and for incising the dura and cutting nerves in
removing the brain

4 *A pair of dissecting forceps* for finer work

5 *A pair of fairly large round ended scissors* for opening
the bowel   These may be of the special type commonly
used   but an ordinary pair, provided the edges are sharp and
the ends blunt, will do almost equally well

6 *A good saw* with removable back.

7 *A chisel*

8 *A wooden or soft metal mallet*

9 *Several flexible probes*

10 *A packing needle*

11 *Strong twine*

12 *Wooden cones* for measuring the diameter or circum
ference of the heart valves (e g   those advocated by
Shennan) will be found useful

In addition it is well to have one or more sharp-pointed
scalpels for any finer dissection that may be required , also a

pair of small sharp-pointed scissors for fine work, a catheter, sponges, and a wooden block for supporting the head A screw-driver for coffin lids may also on occasions be found useful

Knives should, of course, be sharp, and it is advisable to have the means of sharpening them at hand, in the shape of a hone and oil With a little practice it is possible to put a keen edge on a knife in a very few minutes Instead of the finer large knives sold by the instrument makers, butcher's knives will do admirably, and will cost a fourth or fifth of the price

Another necessary item in the pathologist's equipment is a pair of scales with weights from one gramme to five kilos, and a foot rule with inches and fractions of an inch marked on one side and centimetres on the other

Post-mortem Table and Accessories —The post mortem table should be at least 6 feet long and 2 feet broad It should be either a solid slate slab or wood covered with zinc The edge should be raised, and runnels arranged so that fluids will pass to a central waste-pipe enclosed in an iron pillar supporting the table, and on which it revolves There should be a plentiful supply of water, a tap overhead with hose attached, a basin with hot and cold supply close by for washing the hands, a large sink with an ordinary tap, and a tap with rose attached, used for washing organs, the stream from which can be easily controlled by the operator either by the foot or elbow The operator should frequently cleanse his gloves under running water to prevent blood, pus, or other discharge from drying on them Another useful accessory on the table itself is an ordinary cheap galvanised iron pail with six or eight perforations half an inch in diameter within three inches of the brim A rubber or metal tube from a cold water tap is led into this and a constant stream of water permitted to flow Organs may be dipped into the

pail and their surfaces in this way freed of blood or discharges
It is, however, well to remember that tissues which it is
desired to mount subsequently should be washed as little
as possible   Lightly scraping them with a flat knife is a
better method of removing blood or discharges

It is useful to have accessible a number of bottles containing
reagents likely to be required, such as Gram's iodine for
testing for waxy disease (see p 446), dilute hydrochloric acid
and ferrocyanide of potassium for testing for hæmosiderin
in the organs (see p 435), 10 per cent formalin, and other
fixatives for tissues, and a supply of empty bottles with corks

A Bunsen burner, a platinum needle, a piece of metal for
searing the surface of organs, slides, and culture media should
be close at hand   A number of large sponges will be found
very useful for mopping out cavities, also a glass measure and
a syringe and trocars for injecting specimens with preserva
tives   A large jar of Pick s or other fixative should be at
hand for this purpose, and pots of various sizes for containing
specimens

The post mortem room of a hospital should be in a detached
building   The room itself should be airy and well lighted
It should communicate with a preparation room, and a
laboratory for microscopic and bacteriological work   The
bodies should be stored each in a separate numbered recep-
tacle, if possible communicating on the one side with the
mortuary, on the other with the post mortem room   They
should be placed on carriers running on rollers which can be
manipulated from either end   The whole of this storage
system should be artificially cooled   This artificial cooling
is of immense importance in order to delay the progress of
post mortem changes

The operator should, of course, wear a clean overall to
protect his clothing   A waterproof apron over or under
this is advisable   A pair of spectacles for the protection of
the eyes is a good thing

Note-taking —Previous to the performance of the sectio, a short *résumé* of the main clinical features of the case should be sent to the pathologist   Notes dictated by the operator during the sectio should be taken by a competent person   This is absolutely necessary, as the more minute points in the case cannot be put down unless the organs are actually before the operator   Organs change considerably in colour even during the course of the sectio, so that it is not safe to trust to the description of a case written up afterwards, even when the more important organs are preserved   It is well that the rough copy of these notes should be gone over and corrected as soon after the sectio as possible

Post-mortems in Private —In carrying out a *post mortem in private*, the body should be placed on a kitchen table, with an old sheet and newspapers, or, if possible, a waterproof sheet, underneath   Sometimes the bed is the only place available, in which case the waterproof is very necessary   The head should be supported with a brick, a block of wood, or a suitable box wrapped in newspaper   A slop-pail and basins, with a plentiful supply of water, should be procured   To mask unpleasant odours, a piece of twisted brown paper lit at one end, the other end being thrust into a jug and left to smoulder, or a handful of ground coffee thrown on a shovelful of burning coals will be found useful   In private, if the spinal cord has to be examined, it is well to begin with that   A number of newspapers, bottles for specimens, sponges, soap and towels should not be forgotten   When large quantities of fluid are present in the body cavities or in hollow viscera or tumours, it is well to remove this before going far with the examination   This may be done by the use of the sponge or by making an opening for escape, or inserting a trocar in a dependent part and allowing the fluid to drain away into a basin or pail

Rules to be observed in examining Organs —A few

simple rules should be borne in mind when examining an organ   It is well to have some definite method in order that nothing be passed over   The student should remember, in the first place, to *look before touching*, the former being much the more important process   Note in the first instance the size of the organ, and mentally compare it with what, in your experience, is the normal size, remembering always that the age of the subject from which the specimen was taken is an important item in drawing a conclusion as to size   The *general form* of the organ should next be examined, and any deviation from the normal noted, such as swellings or shrinking   Examine next the *surface* of the organ, looking for exudate, which, if recent, is friable and readily scraped away, if organised, it is stringy and difficult to remove   Opaque, white, pearly areas indicate chronic inflammation   *Cicatrices* with indrawing or puckering of the surface indicate old infarcts or healed tuberculous or syphilitic lesions   A *finer roughening*, giving the appearance of morocco leather, is always indicative of fibrosis in the organ.   Before cutting it the organ should be carefully weighed and measured   In the case of the heart, however, it is usual to weigh *after* the removal of all blood clots

Next, the organ should be *incised*, and in doing so some idea of its *consistence* may be arrived at   An organ which is the seat of fibrosis will be tougher and more difficult to cut   In incising an organ it is usual to do so from the rounded outer and broader surface towards the root or hilum where the vessels enter and the ducts leave

The *cut edge* is another point to which attention should be directed, and which bears upon the question of consistence   A rounded edge after a cut indicates soft consistence and is associated with cloudy swelling and fatty change, a sharp edge is found when the organ is firm   That is the reason for the existence of a sharp edge in organs the seat of amyloid disease—the waxy material gives consistency and firmness

to the tissue, unless complicated by other degenerative conditions, such as fatty change

The student is apt to consider that in diseased conditions associated with fatty change, a *greasy feel* is imparted to the organ As a matter of fact, adipose tissue and fat generally is greasy to the touch, but it is only comparatively rarely that fatty change (when the change is actually a degenerative one in the parenchymatous cells) gives to the organs which are the seat of the change a greasy sensation when touched

The next step is to examine the *cut surface* The *colour* and any irregularity in the distribution of the colouring should be noticed The presence of *bands of fibrous tissue*, *pigmentations* of various kinds, *opaque spots* Grey, translucent areas indicate waxy disease or accumulations of cells, such as tubercle foci and leukæmia Opaque white spots are indicative of degenerative and necrotic foci, such as areas of focal necrosis in the liver in typhoid and eclampsia, areas of caseation in tuberculosis and syphilis, and calcareous foci The last are, of course, hard and gritty to the touch Note also the *condition of the vessels* of the organ If they stand out prominently, it is an indication that their walls are thickened Their contents should also be noted, whether that is fluid or solid, and the character of the clot if present The presence of gas in the blood should be looked for

Use of Knife in making Incisions

—In *incising an organ*, the way in which the knife is used is a matter of no little importance The knife should, in the first place, be a large one, considerably larger than the organ itself, the larger the better It must, further, be a sharp knife As regards the character of the cut, the knife should be *drawn along* and not *pressed into* the substance of the organ The cut made by drawing the knife leaves a smooth surface, that made by pressing the knife leaves a rough surface Further, the cuts

must be large and sweeping not a to and fro movement which will leave a series of ridges If possible, the whole cut should be carried out in a single sweep As Virchow was accustomed to say to his students, "Smooth, though wrong, incisions are better than correct and uneven ones"

Channels such as the common bile duct, also medium sized and small arteries, should be slit longitudinally, using a pair of dissecting forceps and sharp pointed scissors It is often well to free and isolate the channel by dissecting it out before opening it This can be done by careful dissection with the point of a small knife

In all medico-legal post mortems it is essential to avoid unnecessary cuts Channels suspected of having been subjected to injury (*e g* the vagina in cases of procured abortion) should be carefully examined *before* any sharp instrument is introduced into them

CHAPTER III

METHOD OF PROCEDURE

Object of Post-mortem Examination.—The object of a post mortem examination is twofold—first, the discovery of the disease condition which has led to a fatal termination in the particular case in point, second, the investigation, as minutely as possible, of that disease condition with a view to advancing medical science in general

The first object may in some cases be attained by the most cursory examination limited to a single organ or part; in other cases only the closest attention to detail and the investigation of the apparently insignificant will be followed by success; the second object can only be attained after every system has been examined with the greatest care and after minute investigation, assisted by the microscope, and, it may be, by the chemical laboratory It follows from this that wherever possible a detailed examination should be carried out There are cases where the cursory investigation will give all the information required, but in a large proportion of cases the pathologist is not doing his duty unless the more detailed examination be resorted to, that is, provided always permission for the extended sectio be obtained and the time and apparatus be available

Necessity for definite Plan of Operation.—In order

to carry out this detailed examination some definite plan of operation is necessary In other words, before starting to carry out the autopsy it is quite essential that the operator should have some idea of how he is going to proceed of the order in which he is going to examine the various body cavities and their contents It is by no means necessary to adhere to the same plan invariably In fact, the experienced pathologist will alter his routine frequently, according to the indications given him by the clinical history as to the parts actually diseased At the same time it is advisable to have some definite plan, some order in which the various parts are to be examined, so that no detail may be omitted

It is generally stated that it is better to begin when possible with the head, as otherwise blood may escape from the vessels of the head while the thorax is being examined, and so appearances be altered This is not a very strong argument Virchow long ago emphasised the necessity of opening the abdominal cavity before the thoracic, in order that the true position of the diaphragm might be ascertained As a matter of fact this is usually done, but not for that reason As a rule, after making an examination of the organs *in situ* and of the large serous sacs—pleura, peri cardium, peritoneum—one begins with the more detailed examination first of the thoracic organs

Different Methods of Procedure —As Letulle points out, there are really two parts in a complete autopsy (1) The examination of the cerebro-spinal system (2) The examina tion of the viscera One might add as a third part the examination of bones, muscles, vessels, and nerves But having admitted that this division exists, it should be realised that the further examination of these parts, more particularly in the case of the viscera, must be carried out *in continuity* That is to say, taking, for example, the vascular system,

heart, arteries and veins should be examined before cutting through any large vessel The alimentary system should be exposed and inspected from pharynx to rectum before it is divided into sections , more than that, the various canals, such as bile and pancreatic ducts, must be examined while they are in continuity with the alimentary tract. This is the ideal method, and it is the method advocated and carried out by Letulle and others The whole of the thoracic and abdominal viscera are removed and examined first in continuity, and then the various organs removed and examined by themselves In practice, however, this method is somewhat tedious, and cannot in many instances be carried out, owing to leave being obtained for the examination only of certain parts of the body

Two great rules emphasised by Orth should always be kept in view The first is that *a part should never be removed from its position before its relationship to its surroundings has been established* Thus the heart should never be removed for examination before the contents of the pulmonary artery and its larger branches have been investigated Secondly, *no part should be taken away if the removal of it will interfere with the investigation later on of other parts*

To sum up, it is well for the pathologist to have some routine to which he is accustomed, thus avoiding the danger of omissions, but this plan may be modified according to the exigencies of the case

Surface Examination—First there comes the examination of the body, before any incision is made The following points should be attended to—

Development of the Body—Height, breadth, etc , presence or absence of deformities Any alterations in the shape of the chest should be particularly noted , the barrel-shaped chest of bronchitis and emphysema, the pigeon breast indicative of rickets in early life are two common malformations

Nutrition —Whether the body is well nourished, poorly nourished, or emaciated

Age and Sex

Presence and degree of *rigor mortis* This is observed first in the muscles of the face, and spreads from above downwards, passing off in the same order *The time of onset* of *rigor mortis* varies according to the time which has elapsed since death and according to the cause of death In cases of sudden death due to injury of the spinal cord, in tetanus, in strychnine poisoning, and in wasting diseases, such as tuberculosis and cancer, the condition may come on very early As a rule it appears in from three to six hours after death Usually the condition begins to *pass off* in twenty four to forty-eight hours, the time depending upon the cause of death and the conditions under which the body is kept In septic conditions and in warm weather rigor mortis passes off rapidly

Alteration in Colour —Pallor Any deepening of the normal colour of the skin or the presence of jaundice

Lividity —This naturally occurs after death, owing to the accumulation of blood in the dependent parts Post mortem lividity is thus most marked in dependent parts Where lips or face are livid, some abnormality in the circulation or death from suffocation may be suspected Lividity may also be due to bruising Such livid patches, when pressed upon, remain of the same colour, unlike post mortem lividity, which can be pressed away When bruised parts are cut into, the blood is found diffused through the tissues A livid colour along the lines of the superficial vessels may be due to the advance of decomposition, owing to the diffusion of the blood-colouring matter into the surrounding tissues Green coloration, an indication of the onset of decomposition, should also be noted It appears first over the abdomen and in the spaces between the lower ribs

Skin eruptions, superficial tumours, scars, or recent

wounds should be carefully noted, and their extent estimated

Note the presence of *œdema* and its distribution It is usually most marked about the feet, ankles, and legs The next most frequent sites are the genitals and face Œdematous tissues often have a clear, translucent appearance They are pale from absence of blood, soft, and they pit on pressure

Examine the various *orifices of the body*—mouth, nose, ears—for discharges, foreign bodies, etc Note the condition of the teeth Examine for the presence of inguinal or femoral hernia Note the condition of the external genitals

Primary Incision —Standing on the right side of the body, the pathologist grasps his knife firmly with the right hand (Fig 1) The incision is commenced either immediately under the chin, at the thyroid cartilage, or just above the manubrium sterni in the middle line It is carried downwards through skin and subcutaneous tissue to left of the umbilicus, as far as the symphysis pubis Any cicatrices or recent incisions should be avoided Care must be taken not to go too deeply when incising the abdomen, in order to avoid cutting the liver or bowel At one point usually in the epigastric region, the incision is carried through muscle and peritoneum into the cavity The index and middle finger of the left hand are then inserted into the opening, and separated so as to put the tissue on stretch (Fig 1) With the knife the incision is prolonged the two fingers following down, to the pubes To obtain more room, the rectus muscle on either side should be cut transversely through immediately above the pubic bone without injuring the skin

In cases where permission is obtained only for the examination of a part of the body—e g thorax or abdomen —the incision should be correspondingly limited

Reflection of Skin and Muscles —The next step in the process is *the dissection of the skin and muscles of the chest*

from sternum, cartilages, and ribs, and, at the same time, of the skin of the neck from the subjacent tissue   This should be done by grasping the skin, etc , with the left hand and steadily pulling away from the sternum or ribs   The areolar tissue and muscles are then touched here and there with the edge of the knife as they are put upon the stretch (Fig 2)   At this stage the operator will be in a position to *determine the amount of subcutaneous fat,* also the *appearance of the muscles,* which in wasting diseases are often abnormally dark and dry, and in toxic conditions such as typhoid fever may show (more especially the recti abdominales) translucent, glassy looking areas—the so-called vitreus degeneration of Zenker   Also at this stage the *mammæ* may be incised through the pectoral muscles and examined for growths, etc   The *ribs* should also be examined for fractures and enlargement of the costo chondral junctions (rickety rosary)   At this stage also some estimate of the relative moistness or dryness of the tissues should be made   Œdematous tissues exude fluid on incision

Removal of Sternum. — Before opening the thoracic cavity the *level of the diaphragm* may be noted   Note also the level of the lower border of the liver, and the position of the stomach and other viscera, as regards the lower costal margin   Then, commencing at the second costal cartilage close to its attachment to the rib, and cutting obliquely outwards, so as to avoid injuring the underlying lung, one divides the cartilages on either side

In many cases of muscular, and more particularly of old men, it will be found impossible to do this with a knife   The saw should then be used, and the cartilages severed, holding the saw perpendicularly to the ribs   Great care should be taken not to splinter the ribs in any way, so to avoid puncture wounds of the hands in subsequent manipulations   An excellent way of avoiding such wounds is to fold the skin

which has been dissected from sternum and ribs in over the severed ends of the ribs

The *sterno-clavicular joint* on either side should then be *disarticulated* by inserting the point of the knife perpendicularly (Fig 3), the knife being afterwards turned edge outwards, the incision prolonged between clavicle and first rib for half an inch, and the rib cartilage divided external to the point of disarticulation. If the cartilage of the first rib is ossified it will be necessary to use a pair of bone forceps or a saw to divide it In these manipulations great care should be taken *not to injure the large* underlying veins This may be a difficult matter if they are distended The point is that any blood which escapes from them will tend to flow into the pleural sacs and mingle with the fluid there

The *sternum and cartilages* should then be *removed* from below upwards, the diaphragmatic attachment being, in the first instance, cut through If the sternum be firmly adherent to the mediastinal tissues, great care should be taken not to damage aneurysm or tumour, to which this adherence may be due

Serous Sacs —The removal of the sternum opens both pleural cavities, and at this stage of the proceedings the *serous sacs*—peritoneum, pleuræ, and pericardium—should be examined The *pericardium* is opened by two incisions, commencing at the lower corner on the right side and extending, the one upwards to the aorta, the other outwards to the apex of the heart In cases where *air embolism* is suspected the pericardial sac should be filled with water, and the right ventricle punctured and pressed, when, if air be present in the right side of the heart, bubbles will appear

The *general aspect of the thoracic contents* should at this point be noted The size of the heart and the extent to which it is overlapped by the lungs are points of importance

In examining the serous sacs look for the presence of *fluid*

in excess, note its colour, whether it is clear or turbid or blood stained   Examine the *surfaces of the viscera*   These ought to be shiny and perfectly smooth   Any dimming of the surfaces indicates inflammatory exudate   Where there are indications of such exudate, films and cultures should be made from the fluid with all necessary precautions   Where *pus* or *fæcal matter* is present *in the abdomen*, careful search should be made for *perforation* of the viscera, more particularly the vermiform appendix, the lower end of the ileum, the stomach, and the duodenum.   A careful examination should also be made of the surface of the viscera for any thickening or adhesions, indicative of ulcerations or tumour formations within

When *blood* or *blood clot* is present *in the abdomen*, search should be made for a ruptured organ, viscus or vessel   An area with adherent blood clot is often an indication of the source of the hæmorrhage

Examine for *adhesions* between visceral and parietal layers of pleura, and note the degree of force required to break down these adhesions

At this stage, *both lungs* should be *freed* from any *abnormal attachment*   If there are extensive adhesions which cannot readily be broken down, an incision should be made through the parietal pleura, and the latter by means of the fingers torn from the ribs

Procedure for removing Contents of Thoracic and Abdominal Cavities —Having examined the serous sacs, the next step is to *remove and examine the contents of the thoracic and abdominal cavities*   The way in which this is done will be determined not infrequently by the nature of the case, the pathologist being guided by the summary of the clinical history, or whatever information is available   To put the matter shortly, there are *two main methods of procedure*   (1) to remove the organs one by one and examine

them separate from their surroundings, (2) to remove the contents of the cavities entire or in groups, afterwards to examine canals, vessels, ducts, etc, in continuity with the viscera, and then, and only then, to sever attachments and remove and examine the organs themselves Unquestionably the latter is the proper method If the former be adopted, although in many cases no harm will be done, in some instances points will be missed and valuable specimens be ruined The experienced pathologist can, as a rule, decide whether he may risk adopting the first method, but the tyro ought, if it is at all possible, to make use of the second But even if one decide for the second method, certain options present themselves One may remove the whole contents of both cavities together as Letulle does, but, as already indicated, this has its disadvantages One may compromise matters somewhat and adopt the method advocated by Shennan, which is excellent, but which necessitates postponing the removal of the thoracic contents (the most important organs in the majority of cases) until all the abdominal organs have been removed

The method recommended by the author is the removal, in the first instance, of the thoracic contents entire, the examination of the vessels, etc, in continuity, then the separation of the organs and their investigation separately Subsequently one deals with the abdomen, from which the organs are removed, not en masse, but in groups This should be the routine method It has certain disadvantages œsophagus, aorta, vena cava, and thoracic duct will be cut through But, as regards the first, the cases in which it is advisable to preserve the continuity of œsophagus with stomach—tumours of œsophagus, cases of poisoning, cases of severe hæmatemesis from varicose veins—are comparatively rare, easily recognised, and special methods can be adopted for the preservation of the continuity As regards aorta, there is no great disadvantage in examining it in two sections And as regards

the thoracic duct, it is only very rarely (as in cases of acute miliary tuberculosis) that it is advisable to dissect it out and investigate it in its entire length

(1) *Removal of the Organs one by one*—Nothing special need be said about the method of procedure in this case It is usual to begin with the heart, then the lungs, spleen, liver, kidneys, etc   In many cases the pathologist will begin with the organ believed to be mainly affected   As far as possible Orth's rules (p 16) should be carried out That is to say, the cavities of the heart should be opened before the organ is removed and the vessels followed up, *e g* the pulmonary artery slit as far as the roots of the lungs

(2) *Method of examining the Thoracic and Abdominal Contents by removing them in Groups* —

EXAMINATION OF THE THORACIC CONTENTS

If not originally begun below the chin, the primary skin incision should be carried upwards to that point   In many cases this may not be necessary, the trachea being cut through at some point above the level of the clavicles   But in some cases it is necessary to have tongue and pharynx attached to trachea   The skin and sterno-mastoid muscles are dissected away from the structures in the neck and beneath the chin The knife is then passed upwards through the floor of the mouth below the symphysis menti, and by sweeping it round on either side, keeping close to the rami of the lower jaw, the attachments of the muscles are cut through (Fig 4)   The tongue can then be pulled through the opening and by drawing upon it a view of the pharynx can be obtained   The attachment of soft to hard palate can then be cut through , the posterior wall of the pharynx is incised and dissected down Care should be taken to include both tonsils in the structures removed   Further traction upon the tongue will then enable

the operator to tear through the loose cellular tissue attaching the œsophagus to the prevertebral fascia   At some point the carotids are cut through, also the subclavian vessels While all this is being done, attention should be paid to any *enlarged glands, thrombosed veins*, etc , which may be met with

The lungs having been at an earlier stage freed from adhesions, a few touches of the knife will enable the operator, by traction on the trachea in a downward direction, to detach the thoracic contents from the prevertebral fascia as far down as the diaphragm   The œsophagus is then ligatured to prevent the escape of stomach contents The œsophagus, aorta, and attachment of pericardium to diaphragm are next cut through, and the thoracic viscera are removed and placed upon a table or in the sink

When it is desired to preserve the continuity of the œsophagus with stomach, and of the thoracic duct and aorta, then the whole of the body contents (thoracic and abdominal) should be removed together, as in Letulle's method   Or a compromise may be adopted and the thoracic organs removed along with the stomach, liver, spleen, pancreas, and duodenum after the last has been ligatured and severed where it joins the jejunum, and the large bowel detached from the stomach by cutting through the lesser omentum   One of these procedures should always be adopted in cases of tumours of the œsophagus and stomach, poisoning with corrosives, and in cirrhosis of the liver

Œsophagus and Trachea —The thoracic contents are now placed, anterior aspect downwards, on the table or sink The œsophagus is slit open with a pair of bowel scissors The trachea and bronchi are opened in a similar manner   If it is desired to preserve the œsophagus, it can be first removed or turned to the left side   After opening the air passages, *the nature of the contents of bronchi and trachea are noted*

Aorta.—In the same way the aorta is slit up and examined as far round as the ascending portion If it be extensively diseased, its continuity with the heart should be preserved The organs should then be placed anterior aspect upwards, and attention should in the first place be directed to the heart

Pulmonary Artery — Incise the pulmonary artery longitudinally, and *examine carefully for the presence of thrombi*, following the branches going to the two lungs as far as possible Very commonly post mortem or agonal clots are present, but these are readily distinguished from thrombi (see p 67)

Superior Vena Cava.—The superior vena cava should then be opened as far as the right auricle The incision is afterwards carried down to the inferior vena cava

Heart—The heart is now separated from the two lungs For this purpose it is advisable to get an assistant to steady the other viscera The organ is pulled upwards and over towards the right lung, and the pulmonary veins are cut through as they enter the left auricle After this the pulmonary artery and aorta are severed In cases where the latter is diseased it may be advisable, as already stated, to preserve its continuity with the heart To do this, a little further dissection is necessary, the aorta being separated from the surrounding structures

Surface of Heart.—The heart is now taken in the hand and a more careful examination of the *surface* made Note should be taken of its *shape* and *size*, of any areas of *thickened pericardium* (milk spots), *small hæmorrhages, fibrinous exudate* The amount of *subpericardial fat* should also be noted

Right Auricle—Then, attention being turned in the first place to the right auricle, an incision is made from the centre of the previous one joining the two venæ cavæ into the auricular appendix, search being made for *thrombi*

Right Ventricle—Passing the forefinger of the left hand through the tricuspid valve into the right ventricle and grasping the wall between the finger and thumb, incise the wall of the right ventricle by means of a probe pointed bistoury, commencing just below the pulmonary artery and carrying the incision down parallel to the interventricular septum and half an inch to the left of it (Fig 5)

Tricuspid Valve.—Now *test the size* of the tricuspid valve either by means of a suitable cone or with the fingers, the normal orifice admitting three digits The *segments of the valve* should then be examined This can be done quite easily from the auricular aspect One of the segments, the largest as a rule, is situated anteriorly and slightly to the left It separates the orifice of the valve from the *infundibulum* or *conus arteriosus*, and is therefore known as infundibular segment The second is situated to the right, corresponding to the free margin of the ventricle, the third lies internally and posteriorly against the ventricular septum, and is known as the septal segment

Pulmonary Valve—The *competence* of the pulmonary valve is now tested by allowing a stream of water to fall from a height into the cut end, the sides of the vessel being supported (Fig 8) The primary incision into the ventricle is then prolonged upwards into the artery, care being taken to cut between the right and left anterior segments Examine the segments for *thickening* or *vegetations* Before leaving

the right side of the heart examine the *thickness of the muscle* of the right ventricle   Note the *amount of fat* lying over it, and particularly if there is any infiltration of the fat into the muscle

Left Auricle — Open the left auricle by an incision joining the two upper pulmonary veins   Continue the incision so as to open the auricular appendix in its entire length (Fig 5)   Examine the interior of the auricle for *thrombi, vegetations,* and *thickening of the endocardium*

Mitral Valve — A longitudinal incision is now made into the wall of the left ventricle, somewhat anterior to the left border (Fig 5)   The mitral valve is inspected from above and its *diameter measured*   This may be done roughly by the fingers, the valve admitting two digits   Run the knife through the valve and out at the opening in the wall of the ventricle and cut outwards   The segments of the valve are arranged, the larger in front and to the right, between the auricular and aortic openings, the smaller to the left and behind, so that, if done properly, the cut will lie between the segments

Left Ventricle — Examine the valve for *thickening, calcareous deposits, vegetations,* etc , also the *chordæ tendineæ* for *thickening, shortening, vegetations,* or *rupture*   Note the appearance of the papillary muscles, incising them and examining for *fibrous change*   Note the *colour* and *appearance* of the *muscle* generally, looking for *fatty* and *fibrous* changes   Examine more particularly the state of the muscle towards the apex of the ventricle where interstitial myocarditis is usually found   Incise the interventricular septum, looking for interstitial change   *Measure the breadth* of the *wall* of the ventricle and *test the consistence of the muscle*

Aortic Valve —Turn next to the aortic valve A good way of exposing this valve is to run the probe pointed bistoury successively into the two coronary arteries and then to cut upwards and outwards (Fig 7) thus slitting up the aorta on either side, and at the same time the commencement of the two coronary arteries Test the *competence of the aortic valve* by a stream of water poured in from above (Fig 8), *examine the condition of the segments* (there are three—an anterior and a right and left posterior) *and measure the circumference*

Coronary Arteries —Next examine carefully the condi tion of the two coronary arteries, opening up their various branches by slitting with knife or scissors, or, in the case of the finer ones, by cutting them across This *should be done most carefully in cases of sudden death* search being made for *impacted emboli or thrombi on atheromatous patches* If required the aortic valve may be exposed more fully by cutting between the anterior and the left posterior segment downwards through the anterior wall of the left ventricle until the lateral cut in the ventricular wall is reached

Certain anatomical points regarding the coronary arteries and their distribution should be remembered The right vessel, which arises from the anterior sinus of Valsalva, is usually smaller than the left, it supplies the greater part of the wall of the right ventricle, the right auricle, and the greater portion of the left auricle It also supplies the ascend ing aorta and first part of the arch by means of two branches from the artery given off immediately after its commence ment The left coronary artery, which arises from the left posterior sinus of Valsalva, soon after its commencement divides into two branches It supplies the outer wall of the left ventricle and the anterior two-thirds of the septum ventriculorum a small part of the right ventricle near the

septum anteriorly, and the inferior portion of the left auricle
The more important of the two divisions of the left coronary
is the descending branch which passes down the anterior
interventricular groove   This branch is the one most
frequently the seat of atheromatous change   It supplies the
apex of the left ventricle and the septum as well as the anterior
wall and papillary muscles   Hence it is in these positions
that chronic interstitial myocarditis is most frequently met
with

Lungs—The lungs should now be separated from the
mediastinal tissues by cutting through their roots

Pleural Surface—Examine, in the first instance, the
pleural surfaces, looking for *petechial hæmorrhages, fibrinous
exudate, fibrous thickening, puckering,* and *cicatrisation,* more
particularly at the apices   Note the *colour* of the organs,
especially at the posterior and the lower parts   Note also
the *consistence, feel for any solid areas* or points at apex
and along borders   Next *cut into the organs* by a perpendicu
lar incision directed from above downwards, and from its
outer, rounded, thick border towards its inner, anterior sharp
border (Fig 6)   Other cuts should be made from the original
incision forwards to the anterior border in the case of each
lobe

Cut Surface of Lungs—On the cut surface, note in the
first place *alterations in colour,* the presence of *cavities, areas
of caseation,* etc   Next *feel the lung substance* and *squeeze it,
looking for the presence or absence of air bubbles* or for the
*presence of fluid, note the colour and appearance of the fluid
expressed   Examine* carefully all *solid areas,* and determine
whether the solidity is due to some exudate filling the air
cells or to interstitial fibrous change   Suspected solid areas
should be placed in a glass beaker of water   *Consolidated
areas sink in water.*

Bronchi.—Next open up the bronchi with the probe-pointed bistoury and note the *appearance of any fluid* they contain, also the appearance of their *walls* Open up the branches of the pulmonary artery similarly, *looking for thrombi or emboli* Incise the bronchial glands, noting the *degree of pigmentation*, the *presence of caseous areas or of calcification*

Lastly, the thyroid, parathyroid, and thymus glands should be examined, also the remaining mediastinal tissue

Thyroid Gland.—The thyroid gland should be examined as regards its *size* Longitudinal incisions are made into its substance and the *cut surface* examined for *colloid material*, the *presence of cysts*, etc.

Parathyroid Glands.—The average number of para-thyroids is four They are found in close proximity with the thyroid gland, usually posteriorly They are minute, oval, pink bodies, averaging from 6 to 8 mm in length

Thymus Gland.—The thymus gland is situated partly in the neck, partly in the mediastinum immediately behind the manubrium sterni It is largest during the second year of life ($\frac{1}{2}$ oz. or 20-25 gm) Until puberty it remains large, thereafter undergoing atrophy, until about the twenty fifth year it has practically disappeared Occasionally it may persist throughout life *An abnormally large thymus gland has been found in certain cases of sudden death, particularly in young children* It is also found in status lymphaticus

EXAMINATION OF THE ABDOMINAL CONTENTS

Removal of Intestines —The first step in this procedure is to *remove the intestines, small and large* The actual examination of these should be deferred to the last moment, in order to avoid the odour of faecal matter Before cutting through the mesentery *search should be made for any enlarged*

glands, more particularly *caseous* or *calcareous glands*, and the relationship of these glands to the bowel established Next *look for the duodeno-jejunal junction*, and having *cut through the mesentery* at that point, *place two ligatures round the bowel and divide it between them* Place a ligature also *round the lower end of the rectum and cut it through as low down as possible* Next *cut through the mesentery*, *close to the bowel*, from the jejunum to ileo-cæcal valve This is easily done by pulling upon the bowel with the left hand and merely touching the mesentery with the knife, which, however, cannot be too sharp for the purpose The knife should be held with its blade perpendicular to the bowel (see Fig 9)

Having freed the bowel as far as the *cæcum*, the latter *should be removed from its attachments*, along with the ascending colon and appendix The transverse colon should next be detached from the stomach and removed with the splenic flexure, descending and pelvic colon In this way the whole of the bowel from jejunum to rectum can be examined in continuity As previously stated, it is well to defer opening it to a late stage in the post mortem examination

Method of opening Bowel.—The *bowel is opened* by means of a pair of bowel or other probe pointed, sharp-edged scissors, *along its mesenteric attachment* in the case of the *small*, *along one of the longitudinal muscular bands* in the case of the *large intestine* (Fig 10) The *colour and general appearance of the contents* should, at the same time, be noted

Examination of Intestine — Having opened the gut, take it up, piece by piece, commencing with its upper end, and *wash it carefully under a gentle stream of water* More particular attention should be paid to the lower end of the ileum, where typhoid and tuberculous ulcerations are specially found, and to the large bowel generally Look for *increase of vascularity, ulcerations, tumours, animal parasites*.

Vermiform Appendix.—The appendix has been looked at during the preliminary investigation of the abdominal cavity. It should now be more carefully examined

It should always be remembered in connection with the intestinal canal that *post mortem changes are most marked in the hollow viscera*, and that these changes *tend to mask the appearances in pathological conditions*. Black and greenish-black coloration of the bowel and neighbouring organs is common, and is due to the action of the sulphuretted hydrogen gas from the gut upon the iron pigment of the blood

Removal of Liver, etc.—In the next place, the *liver*, with the *stomach, duodenum, pancreas*, and *spleen, should be removed* without disturbing the vascular and duct connections of these organs. This can best be done by standing, in the first instance, on the left side of the body, pulling upon the liver with the left hand and cutting through its connections with diaphragm and posterior abdominal wall. Care should be taken at the start to leave intact the right suprarenal gland, which is in close contact with the liver. The duodenum is then detached by cutting through its peritoneal covering. The liver is then pulled still further over to the left side of the body, and its connection with the large vessels and retroperitoneal tissue cut through. Standing on the right side of the body, the cardiac end of the stomach is cut through, the spleen detached all but its vascular connections, the tail of the pancreas dissected away from its left suprarenal, the left lobe of the liver freed from the diaphragm, and the whole group of viscera lifted out. It is more particularly in removing the intestines and other abdominal viscera that an assistant is desirable

Stomach and Duodenum.—Having placed this group of viscera in the sink or on the table near it, the first procedure is to open the stomach and duodenum. This is usually

done by *cutting with the scissors along the greater curvature of the stomach* and along the anterior wall of the duodenum Of all organs, the stomach is the one which suffers most from *post mortem changes*, so that a great deal of what appears to be abnormal in the stomach must be discounted   Look more especially for *ulcers* and *tumours* towards the pyloric end of the stomach, and in the first part of the duodenum *Press upon the gall bladder* to see if bile can readily be made to flow along the common duct into the duodenum

Bile and Pancreatic Ducts — *Incise the common bile duct and pancreatic duct*, pass a probe along them, and if necessary open them up

Gall Bladder — Open the gall bladder and note its *contents*, the *colour and consistence of the bile*, and any *gall stones* which may be present   Ascertain whether the cystic duct is patent by passing a probe along it

Liver — Attention should next be turned upon the liver   In removing that organ any *adhesions* between it and the parietes will have been noted   Any *exudate on the surface* of the organ, *thickenings of the capsule, cicatrices*, etc., should be searched for   The *size* of the organ should be noted, also any *alteration in shape*, the presence of *perpendicular or horizontal sulci*, such as are caused by tight lacing and the wearing of tight belts

OUTER SURFACE — Note *whether the surface is smooth or rough*, also the *colour* of the organ and any irregularity in colouring   *Incise the organ* by means of a number of cuts in a perpendicular direction   Note the *character of the cut edge*, whether rounded or sharp

CUT SURFACE — Examine carefully the cut surfaces, noting *colour*, the *outline of the lobules, irregularities in colour*, etc   Next test the *consistence* of the liver substance by pushing the finger into it   3

Pancreas.—The pancreas is best examined further by a series of transverse cuts The fat in the neighbourhood of the organ should be examined for areas of fat necrosis.

The *portal and splenic veins should then be opened up* and search made for *thrombi* The *lymph glands in the neighbourhood of the head of the pancreas* should also be examined

Spleen.—The spleen, which may be removed by itself or along with stomach and liver, should be *weighed*, its *size* noted, also any *roughening of its surface or thickening of its capsule*, also *irregularities in colour* indicating infarcts Its *consistence* should be noted, and the *organ opened by a longitudinal incision* from its outer surface to its hilum On the cut surface the *general colour*, the *appearance of the Malpighian bodies*, should they be visible, and the existence of any *tubercle nodules* or *other opaque areas* should be noted

All the organs have now been removed from the abdomen with the exception of the kidneys, the pelvic organs, and the large vessels

Removal of Kidneys with Bladder.—Note the position of the kidneys and the courses of the ureters The kidneys and suprarenals should be removed together *Where the existence of renal and bladder conditions is suspected, it is well to remove kidneys, ureters, and bladder together* This can be done by cutting through the blood vessels of the kidneys and dissecting down the ureters to the brim of the pelvis. A cut is now made through peritoneum round the brim of the pelvis down to the bone, and by means of the fingers the bladder, pelvic colon, and, in the female, the genital organs are all separated from their attachments to the parietes, the vessels, etc being cut through close to the bone Grasp these organs with the left hand, pull them upwards and backwards, and cut through the urethra The point of the knife is then pushed down through the skin of the perineum close to the anus A circular cut is made round

the anal orifice and the group of organs is removed and placed in the sink

In the case of the male, when it is desired to retain the continuity between bladder and urethra, as in prostatic disease, cases of rupture of the urethra from fracture of the pelvis, etc, a special method of procedure should be adopted   The pelvic contents are freed from the bony wall as before   The original abdominal incision is then carried downwards for an inch or so along the penis   The penis is then cut through   After freeing the pubic bones from skin and muscular attachments the two rami are sawn through on either side   A little further dissection will enable the operator to remove the whole pelvic contents with the symphysis pubis and root of penis

If it be desired to remove the female genital organs with bladder and rectum, a cut is made all round the brim of the pelvis through the peritoneum , this is separated as above by means of the fingers from the walls of the pelvis, the knife being used occasionally to divide vessels and nerves.   The point of the knife is next pushed down through the skin at one side of the perineum and, by an elliptical cut, the whole floor of the pelvis, including vulva and anus, is cut out.   The pelvic organs can now be lifted out from above.

Suprarenals —Examine the two suprarenals by detaching them from the kidneys and making a series of transverse incisions

Bladder.—The bladder may now be opened by inserting the probe-pointed bistoury into the urethra and cutting upwards to the fundus   Note any *enlargements of the prostate,* *ulcerations of the mucous membrane, stone* in the bladder, etc   *Examine the ureters,* and if necessary slit them up

If there is no obvious reason for keeping the kidneys attached, the ureters are severed at their commencement and the kidneys weighed

The kidneys may be removed by themselves either after the removal of the intestines, or, in cases where it is not considered

necessary to examine these before the other viscera are
touched   This is done by making a cut through the peri
toneum and fascia inserting the fingers, stripping the organ
from its surroundings and pulling it forward   The vessels
and ureter are then cut through

Kidneys—Note in the first place the *size* of the organs
Examine the *surface* for *irregularities* and *cysts*, the more
obvious irregularities of persistent fœtal lobulation or old
infarction, or the finer markings due to chronic interstitial
nephritis   Next *incise the organ* by cutting with the large knife
from the outer border to the hilum (Fig 13), in doing so, note
the *consistence* of the organ   Examine the *cortex*, noting its
colour, its *width*, comparing it with that of the medulla
Look for the *glomeruli*, which may be seen as dark red
spots   Note any opaque lines or patches indicating fatty
degeneration in the tubules. Look at the large *vessels*
between cortex and medulla, and note any *tortuosity* of
the *interlobular vessels* which run upwards from them into
the cortex   Lastly, note the *amount of fat* which is present
between the kidney substance and the pelvis (perinephric fat)
and examine the pelvis itself

Then, taking the kidney in the right hand, grasp the *capsule*
of the organ with a pair of dissecting forceps and *strip it
backwards*   In a normal kidney this can be done quite
easily, and the surface displayed is perfectly smooth   If the
capsule is *thickened* and *adherent*, or if the *surface is rough*,
the presence of chronic interstitial nephritis is certain   The
appearance of the *small cysts*, so frequently found under the
capsule under similar conditions, should also be noted   Note
also whether small veins (venæ stellatæ) under the capsule
are unduly prominent.

Uterus and Appendages—The uterus is examined by
making an incision into it from fundus to cervix, and trans-
verse incisions along the upper border, so as to display the

openings of the Fallopian tubes   The ovaries are incised in their longest diameter

Testicles — The testicles may be examined without injuring the scrotum by incising the tissues at the external abdominal ring and pressing the testicle upwards   The gland is opened by an incision in its longest diameter.

Thoracic Duct, etc.—There only remain now for examination the large vessels, the thoracic duct, the retroperitoneal glands, and the cœliac ganglia   The *inferior vena cava, aorta, and their branches* are slit with scissors along their anterior walls and search made for thrombi and emboli

The *thoracic duct* will be found behind and to the right of the aorta   In the thorax it lies to the right between the aorta and the azygos vein   It should be examined more especially in cases of *miliary tuberculosis* and its relation to any caseous lymph gland investigated

The *semilunar ganglia* will be found on the aorta around the cœliac axis

EXAMINATION OF THE BRAIN

Scalp Incision.—Place a block under the nape of the neck to support the head   Insert a small knife with its back to the skull under the skin immediately behind the right ear, cut upwards and outwards to the vertex and from the vertex in the same manner down to a corresponding point behind the left ear   It is advisable to cut outwards in this way in order that the hair may not be cut off   It is well also, in the case of women, to separate the hair along the line of the incision, throwing part forwards and the other part backwards   Raise a portion of the scalp by means of the hair and cut below it with the knife   Then grasp the portion of scalp freed with the left hand, and, pulling forwards

or backwards as the case may be, put the tissues joining scalp to skull and temporal muscle on the stretch, rendering the cutting of them more easy This should be done forward, nearly to the supraciliary ridges, and backwards to below the occipital protuberance In carrying this out, *note the presence of any extravasation of blood below the scalp and examine the surface of the skull for fracture*

Saw Cuts—Next, by means of an old knife, mark out the line along which the bone is to be sawn through In front, this line should run below the frontal eminences, and be carried back on either side, cutting through the temporal muscles to a point just above and behind the ears Another cut starts from one of these points, and, making an angle of about 160° with the former cut, runs across the back of the skull a little in front of the occipital protuberance to the corresponding point on the other side

Next, standing on the right side of the body, take a dry towel and throw it over the skull, place the left hand on the towel and through it grasp the calvarium, throwing the anterior portion of the towel over the back of the hand Take the saw in the right hand and commence to saw through the outer table of the frontal bone, following the previously mentioned lines as closely as possible The saw-cut should be carried nearly, but not quite, through the inner table, in order to avoid injuring the membranes and brain When a fracture is suspected, however, it is well to carry the saw-cut through both tables Then, taking the hammer and chisel, insert the edge of the latter into the saw-cut; and, by a series of sharp taps, crack through the remainder of the inner table It is well to tilt the chisel slightly, so that the angle of the instrument enters first.

Removal of Calvarium.—The next step is to pull back the calvarium by means of the hook on the cross-piece of the chisel, at the same time separating the dura from the

bone with such an instrument as a periosteum separator
In the case of old people, alcoholics and also young children
the dura may be found too firmly adherent to the bone for
this In such a case the dura should be divided all along
the saw cut and removed at the same time as the calvarium
Incise the *superior longitudinal sinus* and examine for clots
or thrombi

Dura Mater —With a pair of dissecting forceps pick
up a portion of the dura mater anteriorly and incise it
Insert a probe pointed bistoury into the opening and cut
round the dura on both sides, at the level at which the skull
was sawn through   Insert the knife between the left frontal
lobe and the falx cerebri with the edge towards the falx
Cut through the latter and pull back the dura mater   The
dura will usually be found adherent over the vertex by
means of vessels and Pacchionian bodies

Brain Surface —Examine the exposed surface of the
brain, noting its vascularity, any *flattening of the convolutions*,
or *filling up of the sulci with exudate* or blood

Removal of Brain —Insert two fingers of the left hand
under each frontal lobe and gently pull the brain back
Detach the olfactory bulbs from the cribriform plate with the
handle of the knife   Cut through the optic nerves and the
internal carotid vessels as near the bone as possible   Cut
through the 3rd, 4th, 5th, 6th, and 7th nerves   Cut the
tentorium cerebelli along its attachment to the petrous
portion of the temporal on either side (Fig 11)   Divide the
8th and 9th nerves   Pass the bistoury down the cord and
divide it obliquely as low down as possible   Sever the two
vertebral arteries and a few nerve roots and the brain will
tilt back into the left hand

Cerebro-spinal Fluid.—During all this process, cerebro-
spinal fluid will escape   Note the *amount* and *character* of

this fluid, whether clear or opaque, and, if necessary, secure a specimen for further examination

Base of Skull.—Either before or after the examination of the brain, the base of the skull should be further investigated. The *lateral and other venous sinuses* should be slit open and their *contents examined*. Where *fracture is suspected*, strip off the dura mater from the bones by means of dissecting forceps.

Examination of Brain—The brain should now be *weighed* and its *surface further examined*. Note the *condition of the vessels*, more particularly those at the base, looking for *opaque areas of atheroma*, *thrombi*, or *small aneurysms*. Note *thickening or opacity* of the pia arachnoid. Examine for *exudate* in the subarachnoid space, more particularly at the base of the brain. Examine the Sylvian fissures on either side for *small tubercles* along the lines of the vessels. Pass the fingers carefully over the whole surface of the organ, noting the *presence of any area of exceptional softness*.

The method of proceeding further with the examination of the brain depends to a great extent upon the pathological condition present. In a large proportion of cases it is advisable to fix the organ before cutting it up. This is done by injecting 10 per cent formalin, or Pick's or some other preservative, into the larger vessels at the base, placing the whole organ in similar fluid, padding the jar, in which it is suspended by means of a piece of string run through the basilar artery and attached to the lid of the jar, with cotton wool, and leaving it there for some days at least.

Section of Brain.—When it is necessary at once to examine the whole organ, it should be placed vertex downwards and the pons and medulla removed by cutting through the crura cerebri. The cerebrum is then placed upon its

base, and with a large and sharp knife a series of horizontal sections are made at intervals of half an inch, commencing at the vertex, the organ being steadied by means of the left hand placed flat upon it. The pons and medulla are then opened up by means of a series of transverse cuts and the cerebellum examined by an incision from its posterior border to the peduncles Search is then made on the cut surfaces for *hæmorrhages*, *areas of softening*, *tumours*, etc

EXAMINATION OF THE SPINAL CORD

Removal of Spinal Cord.—Turn the body over on the face, with the head hanging well down over the end of the table Make an incision through the skin over the spinous processes from the occiput to the sacrum Cut the muscles through on either side down to the laminæ, pulling aside the muscles from the spinous processes Then saw through the laminæ on either side about one half inch from the middle line, directing the edge of the saw slightly inwards It is unnecessary to saw below the third or fourth lumbar vertebra, as the cord does not reach farther than the second lumbar A rough guide for the lower end is the crest of the ilium

Having partially sawn through the laminæ, complete the process with the hammer and chisel, taking care not to damage the cord Lift up the spinous processes thus set free at some point, and then, with the bone forceps, proceed to bite through the remainder of the laminæ on either side, lifting up the spinous processes as you proceed This should be done above as high as the atlas and below as far as the 3rd or 4th lumbar Free the cord at the lower end by cutting through the nerve-roots and the dura , then, holding dura and cord, cut through the nerve-roots upwards, if necessary removing the ganglia with the roots

At the upper end of the cord cut through the dura from above, *i e* through the foramen magnum, and remove the

whole cord Next lay the cord on a flat surface, incise the dura anteriorly, and preserve the cord in the first instance in 10 per cent formalin After two or three days make a series of transverse cuts, dividing the cord into a number of segments which remain attached posteriorly to the dura. Subsequently, thinner portions may be placed in Muller's, Marchi's, or other fixative.

In cases where it is desirable to retain the continuity between brain and cord, as in cases of lesions of the cervical region, the cord should be exposed first and all the nerve roots severed The dura mater of the upper portion of the cord is cut through from above, also the upper nerve-roots, and if desired the cord at the level of the foramen magnum may be exposed by taking a wedge-shaped piece of bone from the back of the skull The cord will now come away with the brain

Eye and Orbit.—The eye and contents of the orbit may be examined by chipping through the orbital plate of the frontal and removing the pieces of bone with a pair of bone forceps beginning at the optic foramen The posterior half of the eye can then be removed by making an equatorial cut with a pair of sharp-pointed scissors without damaging the appearance of the face

Middle Ear—The middle ear and mastoid antrum can be readily examined after stripping the dura from the base of the skull, by chipping off the upper surface of the petrous portion of the temporal bone with a chisel, or by merely opening through the thin tegmen tympani For more careful examination it will be necessary to remove the petrous portion of the temporal entire and decalcify it in bulk, afterwards cutting it up (Fig 12)

Other Accessory Cavities.—The frontal, ethmoidal and sphenoidal sinuses can be opened up by chipping away portions of their bony walls (Fig 12)

Another method is, after stripping the dura, to make a saw-cut (Harke's) through the base of the skull in its sagittal diameter a little to the right of the middle line (Fig 12), care having been taken in the first instance to dissect the anterior flap of skin down to the root of the nose, the posterior well down behind the occiput   In making the saw cut the hard palate and two upper cervical vertebræ must be severed, and great care must be taken not to injure the external surface of the face The two halves of the skull can then be separated and the right frontal sinus, the ethmoidal labyrinth, and the sphenoidal sinus examined   The *nasal cavities* can be examined at the same time

In all cases of meningitis careful examination should be made of the cavities in the skull

The maxillary antrum is best opened by lifting the upper lip, dissecting upwards and subsequently chiselling through the bony wall of the cavity

Summary of Steps in Method of Procedure

1 External appearances

2 Primary incision reflection of skin and muscles removal of sternum

3 Examination of serous sacs — pleuræ, pericardium, peritoneum

4 Removal of contents of thoracic cavity, examination of

    (*a*) Œsophagus

    (*b*) Larynx and trachea

    (*c*) Aorta

    (*d*) Pulmonary artery

    (*e*) Heart

    (*f*) Lungs

    (*g*) Mediastinal contents

5 Ligature of intestine at junction of duodenum and jejunum, and removal of whole intestinal tract

6 *Removal of stomach and duodenum, liver, spleen and* pancreas, and examination of these in detail

7 Removal of kidneys, suprarenals, ureters, and, if necessary, of the bladder in continuity with these

8 Removal and examination of pelvic contents and testicles

9 Examination of abdominal aorta, etc.

10 Opening up skull, removal and examination of brain

11 Examination of base of skull and accessory cavities

12 Removal of spinal cord

13 Examination of peripheral nerves, bones, joints, vessels, etc.

14 Opening and examination of intestine.

LETULLE'S METHOD

After the preliminary incision and the removal of the sternum, the floor of the mouth is cut through close to the jaw, and the tongue, pharynx, tonsils, larynx, œsophagus are dissected down along with the carotid arteries, jugular veins, thyroid and lymphatic glands   The pleuræ are then examined Should there be no adhesions present, the left lung is drawn over, the operator standing on the right side.   The pleura is then cut through longitudinally where it is reflected from the vertebræ on to the lungs and mediastinal contents   The intercostal arteries are then cut through and the œsophagus and other contents of the posterior mediastinum detached from the prevertebral fascia by pulling gently   The same thing is then done for the right pleura, the operator standing on the left side, care being taken in this case not to injure the thoracic duct and the vena azygos major   The brachial plexus and the subclavian arteries and veins are then cut through at the inner margin of the first rib, and the whole contents of neck and thorax are free   In cases where there are extensive firm adhesions between parietal and visceral pleura it is *necessary to tear away the parietal pleura from the ribs and* intercostal muscles by means of the fingers   The attachments

of the diaphragm are then cut through, taking care not to injure stomach or liver The whole of the parietal peritoneum is then stripped, along with the abdominal contents, including kidneys, vessels, etc., leaving only the psoas muscles The iliac vessels are cut through as low down as possible The peritoneum is stripped from the sides of the pelvis, the skin is cut through round the anal orifice, and the whole of the viscera removed and placed upon a dissecting table.

The examination of the parts in detail commences by placing the viscera with their posterior aspect upwards and opening the venæ azygos major and minor and the thoracic duct. The suprarenal glands are then removed and examined. The ureters are isolated and opened, the kidneys removed and examined The aorta and the inferior vena cava are then opened throughout their length The trunk and rootlets of the portal vein are isolated and opened up and the common bile duct examined The aorta is then dissected away from other structures and the œsophagus and cardiac end of the stomach isolated The tongue, pharynx, and tonsils are then examined and the œsophagus, trachea, and bronchi opened up The vagus and other nerves and the lymph glands of the neck are investigated. The viscera being turned over, the thymus and thyroid glands are examined. The superior vena cava and its tributaries are then opened Next, the pericardium is opened, and the first part of the aorta, the pulmonary artery and veins and their branches outside the lungs are opened up The heart is next examined externally and removed from its attachments The lungs are also detached and examined. After examination of the diaphragm, the liver and its bile passages are investigated and detached, also the spleen Next, the stomach, pancreas, and duodenum are isolated and, along with the œsophagus, removed, opened up, and examined The intestinal canal is then examined from the outside, detached, opened, and investigated in its various sections The examination finishes with the genital organs and urinary bladder

SHENNAN'S METHOD

The organs are removed in the following order —

(1) Small intestine,—with or without—

(2) Large intestine.

(3) Stomach and duodenum, with liver, bile ducts through out their whole length, pancreas, spleen, and mesentery

(4) Kidneys with suprarenals and ureters.

(5) Thoracic contents along with the cervical soft structures, the aorta in its whole length, inferior vena cava, crura of the diaphragm with solar plexus and receptaculum chyli.

(6) Pelvic organs, which in certain cases may be removed in continuity with large intest ne, and kidneys

Stitching up Incisions   Toilet of the Body—After the completion of the examination it is absolutely essential that the body be restored as nearly as possible to its original condition.

In the first place all fluid should be got rid of by tilting the body or by swabbing out the cavities with sponges The organs are then replaced and sawdust, wool, tow, or newspapers used to compensate for the loss of fluids, etc. Firm plugs of wool are then placed in the mouth, anus, vagina, etc., in order to prevent the escape of any fluids.

The skin incisions are closed by means of the glover's or blanket stitch, a packing needle and strong twine being used In carrying out this procedure the needle is always passed from within outwards, the slack of the twine being held firmly between the fingers of the left hand (Fig 14)   The stitches should be about half an inch apart.

Finally, all trace of blood is removed from the surface of the body by sponging and subsequently wiping with a towel

Cleansing of Gloves and Hands—After completing all operations in which the hands come in contact with the body or its contents, the gloves, while still on the hand, should be washed in cold running water, at first without, then with soap   Subsequently they are washed in biniodide

of mercury spirit or merely in methylated spirit. They are then removed from the hands, and if any leakage of blood or other fluid has occurred the interior should be treated in a similar fashion

The hands are then thoroughly washed with soap in cold running water.

NOTE —In cases where injury to the skull is suspected it is well not to use the chisel and hammer but to saw through the entire thickness of the skull at the risk of damaging the dura.

Instead of adopting the two saw cuts at an angle of 160° many pathologists make a continuous circular cut   The advantage of the two cuts is that the calvarium remains in position better after the scalp has been stitched.

It is usual not to attempt to replace the brain within the skull but, after plugging the foramen magnum with a small piece of wool, to pack the cavity lightly with wool, tow, or crumpled paper, and then fit the calvarium on.

CHAPTER IV

DISEASES OF THE HEART AND PERICARDIUM

MALFORMATION OF THE HEART AND GREAT VESSELS

THE heart is developed in the first instance as a single tube, with primitive auricle, ventricle, and aortic bulb The structure later becomes bent upon itself and septa appear in all three divisions, so that eventually there are two auricles, two ventricles, and two vessels—the aorta and pulmonary artery The commonest congenital malformations of the heart are associated with defects in the formation of these septa

1 **Defective Interauricular Septum.**—A degree of this, i e slight patency of the foramen ovale, is a very common occurrence (30-50 per cent of cases) In the vast majority of the cases, owing to the smallness of the aperture and to its oblique direction, there is no interference with the function of the organ. In cases of stenosis of the pulmonary artery or aorta, however, the defect in the septum may be marked

2 **Defective Interventricular Septum.**—The separation of the ventricle into two begins near the apex. The septum rises towards the base The last portion to form is the portion represented by the "undefended spot" in the

fully developed heart It is at this point that defects in the septum most commonly occur As in the case of defective interauricular septum, patency is usually associated with defects in the vessels, most commonly with stenosis of the pulmonary artery Complete absence of the septum results in the so-called three-chambered heart.

3 Congenital Stenosis of the Pulmonary Artery — This is one of the commonest congenital defects and its existence leads to a number of others—defective inter auricular and interventricular septa and patency of the ductus arteriosus The narrowing may occur at the valves or in the artery beyond the valve The cause may be (1) malformation of the septum dividing pulmonary artery from aorta, the septum being found too far to the right (2) Fœtal endocarditis All degrees of the condition to complete obliteration or atresia may be found

4 Congenital Stenosis of the Aorta —This is much more rare than the preceding condition Again, it may occur at the valve or in the vessel beyond When it occurs at the valve there is usually defect of the septa superadded Stenosis of the vessel beyond owing to the persistence of the ductus arteriosus, is not of so much importance, the circulation being carried on through the latter vessel Stenosis is sometimes caused by a circular fibrous band at the point where the ductus arteriosus joins the aorta

5 Persistence of the Ductus Arteriosus or, in other words, patency in extrauterine life of the communication between the pulmonary artery and the thoracic aorta accompanies other defects, such as narrowing of the pulmonary or aortic orifices

6 Abnormalities in the Valves —These mostly occur in the semilunar valves (a) There may in the first place be *complete fusion* of the segments leading to stenosis (b) There
4

may be *only two cusps*, a large and a small one, the larger in some cases showing evidence of partial division into two (c) *The segments may be abnormally numerous* There may be four instead of three, and all differing in size (d) *The segments may show fenestrations* This is a common occurrence, but as the openings are usually close to the free margin and as the area of contact of the segments extends some distance from the free margin, there is no incompetence of the valve as a result.

Of congenital anomalies of the auriculo ventricular valves the commonest is *coalescence of the segments of the tricuspid valve* This may be due to fœtal endocarditis It leads to patency of the foramen ovale

7 Abnormalities in the Great Vessels —There may be *transposition* of the aorta and pulmonary artery, so that the latter takes origin from the left ventricle, the former from the right Occasionally a *double aorta* is met with—a condition found normally in reptiles Or the *aorta may pass to the right*, the condition found in birds.

The *heart may be situated to the right side of the body* This may or may not be associated with transposition of the other viscera. Occasionally the *pericardial sac is absent* and the heart may be situated in the abdomen (ectopia cordis)

DISEASES OF THE PERICARDIUM

Under the term *pericardium* are included (1) the sac formed of fibrous tissue, triangular in shape, whose base rests upon the diaphragm, and whose sides are attached to the pleuræ laterally the lower portion of the sternum anteriorly, and the mediastinum posteriorly, (2) the serous endothelial lining of this (parietal pericardium) which is reflected on to the surface of the heart (visceral pericardium or epicardium), and (3) the subserous connective tissue and fat No hard and fast line can, of course, be drawn between diseased conditions of the epicardium and those of the myocardium.

If one is affected, the other of necessity must be   For purposes of classification it is necessary, however, to draw a distinction between them.

After the removal of the sternum and costal cartilages the position of the pericardial sac and its contents as regards the other structures in the thoracic cavity should be noted, also any abnormal distention of the sac.   The pericardial sac is, of course, one of the serous sacs or large lymphatic spaces of the body, and as such it is liable to conditions which tend to affect these sacs   Such are œdema or over filling of these spaces with lymph, inflammatory conditions, more particularly in acute rheumatism

Hydropericardium, or dropsy of the sac — There is always a small quantity of clear, straw-coloured fluid in the sac (about $\frac{1}{2}$ oz)   When this is increased to any extent the term *dropsy* is applied   The condition is usually a late manifestation of general dropsy, the cause being commonly kidney or heart disease   Œdema of the tissues of the pericardium themselves may not unfrequently be observed, either accompanied by dropsy of the sac or without it

Hæmopericardium, or blood in the sac —This is a very rare condition   It may be due to (1) *a penetrating wound*— bullet wound or stab , (11) *rupture of the heart* from (a) degenerative changes in the muscle associated with obstruction to the coronary arteries (common position, the anterior aspect of the left ventricle close to the septum and not far from the apex), (b) abscess of the heart wall communicating with one of the cavities (Fig 16), (c) injury—a crush (common position, base of heart) , (iii) *rupture of an aneurysm* of the heart itself, of one of the coronary arteries or of the commencement of the aorta, (iv) *very acute inflammation* of the pericardial sac

Small extravasations of blood into the substance of the subpericardial tissue (ecchymoses or petechial hæmorrhages) are fairly common   They are found in toxic conditions and

in severe anæmias They are chiefly situated at the base of the heart, and often on the posterior aspect.

Pneumopericardium, or air in the sac.—A very rare condition, usually associated with purulent pericarditis due to rupture of the œsophagus or stomach into the sac. The gas may be due to the presence of germs, *e g B aerogenes capsulatus*

INFLAMMATION OF THE PERICARDIUM
(PERICARDITIS)

Types

    1 Acute pericarditis
        (a) Fibrinous, (b) serous, sero-fibrinous, (c) puru
        lent, (d) hæmorrhagic.

    2 Chronic pericarditis, (a) following acute, (b) " milk
        spot "

    3 Adherent pericardium

    4 Tuberculous pericarditis

1 **Acute Pericarditis.**—This is due invariably to the presence of some germ Those more commonly found are *micrococcus rheumaticus, staphylococci, streptococci, pneumococci,* etc The condition occurs in the course of acute rheumatism, pyæmia, pneumonia, kidney disease, the organisms reaching the pericardial sac by the blood or by continuity of tissue from lung, pleura, mediastinum, or heart wall

The essential point in pericarditis is the presence of an exudate on the surface of the pericardium which coagulates, thus roughening it and causing it to lose its gloss The amount of this exudate may be very small, forming a mere roughness on the surface, or it may occur as an irregular, thick, opaque, white layer producing a shaggy appearance (*cor villosum* Fig 15). If the pericardial surface is visible the vessels are seen to be injected The exudate may be

red in colour from hæmorrhage The amount of fluid in
the sac in this condition is variable Sometimes it is small,
forming the so-called " dry," plastic, or *fibrinous* variety,
found more especially in kidney disease and in pneumonia
More commonly there is some free fluid with flakes of lymph
floating in it In such a case the term "*serous*" or "*sero-
fibrinous*" may be applied In some cases the fluid is
purulent, more especially in pyæmia or septicæmia. Occa-
sionally, in intense inflammations, blood in considerable
amount is mixed with the exudate (*hæmorrhagic pericarditis*)
In the early stages the fibrinous exudate can easily be re
moved Later on, when organisation has commenced, it
will be found bound down by fine threads which represent
penetrating young blood vessels

Microscopic Appearances —The vessels of the subpencardial
tissue are dilated. There is a meshwork of fibrin on the
surface of the pericardium, and some in the spaces of the
tissue itself. Numerous leucocytes (chiefly polymorphonuclear)
are found infiltrating the pericardial tissue and caught in the
meshes of the fibrin on the surface In the early stages the
endothelial cells are swollen and vacuolated, later they
become detached and occur in the fibrin

Later on, evidence of organisation of the exudate is found.
The endothelial cells of the vessels of the subepicardial tissue
are swollen and show evidence of proliferation Small buds
can be seen protruding from these vessels and making their
way into the fibrinous exudate. At the same time there is
swelling and proliferation of the connective tissue cells generally
The newly formed cells (fibroblasts), which are at first small
and rounded, with a fair amount of pale staining protoplasm
and a rounded, relatively small nucleus accompany the newly
formed vessels into the exudate. Where organisation is
advanced, the fibroblasts farthest from the pericardium will
still be round, while the deeper ones will be spindle shaped and
arranged parallel with the vessels, still nearer the pericardial
surface they tend to lie parallel with that surface and perpen
dicular to the direction of the new blood vessels From the

protoplasm of these older fibroblasts the collagenous fibres of the new tissue are developed

In suitably stained specimens micro organisms may be found.

Results (1) the exudate may be absorbed, and matters return to the normal

(2) Organisation with union between heart and pericardial sac may take place (Adherent Pericardium) This union may be partial or complete If complete, more especially if the surrounding tissues of the mediastinum participate in the inflammatory process, great interference takes place with the action of the heart, with the result that it tends to dilate

(3) If the exudate be not absorbed it may be the seat of deposit of lime salts, the result being the formation of calcareous plates This is a rare occurrence

2 **Chronic Pericarditis** —This may follow acute, or it may develop slowly, the result of friction (a) Following acute, the condition is usually associated with adhesion between visceral and parietal pericardium (b) A more common variety of it consists in the fibrous thickenings of the pericardium, often called ' milk spots " or " soldier's spots " These are white, opaque, well-defined areas, often with a tendinous appearance They are most frequently found on the anterior surface of the right ventricle Another common site is the anterior surface of the left ventricle close to the apex. Similar areas are often found thickly covering the surface of the auricles They are also not infrequently found along the course of the coronary arteries They are more particularly found in hypertrophied and dilated hearts, and are due to constant friction

Microscopically all that is to be seen is a thickening of the fibrous tissue under the endothelium.

3 **Adherent Pericardium.** —This condition not infrequently follows acute fibrinous pericarditis The layers of

fibrin on visceral and parietal pericardium become organised. Young connective tissue forms between these layers, and the heart is permanently attached to the pericardial sac   This may occur over a limited area, frequently at the apex of the left ventricle   Very often, however, it occurs all over   The inflammatory change may also spread to surrounding structures, such as pleura, mediastinum   The mediastinal glands are enlarged and firm   In this condition the heart is usually enlarged, the cavities being dilated and their walls thickened There is backward pressure from relative incompetence of the valves, and chronic venous congestion of the organs, such as lung, liver, and spleen   The condition not infrequently causes death from constant excessive strain on the heart

4 Tuberculous Pericarditis —This may occur as a subacute condition associated with the presence of small grey and yellow nodules of tubercle   It is often combined with general miliary tuberculosis   Sometimes the tubercle nodules are found along the course of the coronary vessels without any other evidence of inflammation being present, and sometimes there is excessive distention of the pericardial sac by fluid, and a thick layer of fibrin may cover the heart and line the sac   The true nature of these latter cases may not be recognised until microscopic sections are examined, when the characteristic focal aggregations of epithelioid cells with occasional giant cells clinch the diagnosis   Tuberculous pericarditis is, however, a rare condition in the human subject   It is relatively much more frequent in the bovine species

DISEASES OF THE MYOCARDIUM

DEGENERATIVE CHANGES

Atrophy —In old age and in wasting diseases, such as tuberculosis and cancer, the heart tends to get smaller,

sometimes being reduced to one-third of its usual size. As the process goes on the epicardium which does not participate in the shrinkage, becomes wrinkled, the vessels more tortuous, and the fat under the epicardium reduced in amount. At the same time the muscle substance becomes a darker brown colour. This condition is known as *brown atrophy*. The brown colour is due to the increase of the pigment found normally in the muscle cells and is probably a coloured fat or lipochrome.

Microscopically the individual fibres of the myocardium are sometimes smaller than normal but the main change is an increase of the golden yellow granules of pigment which are found in small amount normally at the two poles of the nuclei.

Cloudy Swelling —This condition is found accompanying infective diseases, more especially those associated with high temperature. The muscle substance is pale, soft, and friable. The friability can be tested by pushing a finger into the muscle.

Microscopically there is often very little alteration to be seen. The individual fibres are somewhat swollen and granular, and there may be some loss of *longitudinal and occasionally of transverse striation*.

Fatty Changes —Types.

    1 Due to increase in the subpericardial fat
       (a) Fatty loading
       (b) Fatty infiltration

    2 Due to degenerative changes in the muscle fibres (fatty degeneration)
       (a) Diffuse form
       (b) Patchy form

    1 *Fatty Loading and Fatty Infiltration* —This condition comes, strictly speaking, under diseases of the pericardium, but for the sake of contrast with fatty degeneration it may be taken here.

There is in all healthy hearts a certain amount of fat in the subpericardial tissue, more especially in that covering

the right ventricle   It occurs particularly along the lines of the vessels and at the base between the auricles and ventricles. In very fat people this adipose tissue is increased in amount, so that not infrequently the whole of the anterior surface of the right ventricle may be covered by it   This is what is known as *fatty loading* of the heart   The increase of fat may also occur in anæmia and in association with atrophy of the heart muscle

As the fat increases in amount it tends to make its way along the lines of the vessels which penetrate into the muscle substance, leading to indistinctness in the line which separates fat from muscle   When this has occurred, the term *fatty infiltration* is applicable (Fig 18)   The fat in this way tends to separate the bundles of muscle substance from one another, and to cause an atrophy of these by pressure   This fatty infiltration of the heart often accompanies fatty loading, but it may occur where there is relatively little increase in the amount of subpericardial fat

Microscopically, the rounded fat globules can be seen passing down from the subpericardial fat along the lines of the vessels into the muscle substance   The muscle fibres themselves are compressed and atrophied.

2 *Fatty Degeneration* —This is a totally different condition from the preceding   It is a degenerative change *in the muscle fibres themselves*   It is found more especially in toxic conditions, such as alcoholic or phosphorus poisoning, bacterial diseases, and in severe anæmias   Two forms of it are distinguished   (1) a *diffuse form*, where the whole muscle substance is uniformly pale, soft, and friable , (2) a *patchy form*, which is usually best seen towards the inner portion of the wall of the left ventricle, more especially in the papillary muscles   In this position the muscle has a mottled appearance, with small transverse parallel patches— the so-called " thrush breast " mottling or " tabby cat " striation   " Tigering " and " faded leaf appearance " are also descriptive terms which have been applied

Microscopically groups of muscle fibres are found containing numerous small droplets of fat in their protoplasm. There is at the same time some loss of striation both transverse and longitudinal

Fragmentation and Segmentation of the Heart Muscle—This is a condition sometimes seen in old people, also in acute and chronic infective conditions, in diseases of the central nervous system, and in sudden death from various causes It does not necessarily give rise to any gross changes although cloudy swelling is often associated In such cases the muscle is soft, friable, and somewhat opaque The chief change is found on microscopic examination when the muscle *cells are seen separated from one another by gaps—segmentation*—or, it may be, broken across within the fibrous sheath—fragmentation It is doubtful at present how far these changes are agonal or possibly even due to post mortem changes

Calcareous Degeneration.—Deposit of calcium salts may occur in an area of necrosed muscle following infarction A ring of calcareous deposit is sometimes met with in aged individuals in the myocardium close to the attachment of the mitral valve The mitral valve is itself usually also thickened and the muscle around is fibrosed Owing to its situation this ring of degenerated muscle may involve the bundle of His *Calcification of unabsorbed exudate in the pericardial sac has already been mentioned*

ALTERATIONS OF THE CIRCULATION

Chronic Venous Congestion.—This occurs in conditions where there is backward pressure on the right auricle and therefore on the blood in the coronary sinus It is accompanied by chronic venous congestion in other organs The muscle substance is firmer and thicker than usual and is dark in colour, and usually has a translucent look from oedema

Microscopically there is excessive distension of the veins and capillaries with blood

Effects of Obstruction of the Coronary Arteries on the Myocardium —The branches of the coronary arteries within the heart belong to the group of what were originally called " end " arteries They are not as a matter of fact entirely devoid of collateral communications, as the name would indicate, but such communications as they have are small, so that when a branch is blocked the circulation cannot be fully restored, and *infarction* occurs The effect of the obstruction of these branches upon the heart depends to a large extent upon whether it is *sudden* and *complete* or whether it occurs *slowly*, and is therefore, for some time at any rate, *partial*

1 *The effect of sudden obstruction* of a large branch of one of the coronary arteries is, as a rule, to produce instant death When the branch is a small one and the patient recovers, infarction occurs The *cause* of the obstruction is either thrombosis upon an atheromatous patch in the artery or impaction of an embolus More usually it is the former *In all cases of unexplained sudden death careful search should be made for such thrombi by slitting up the branches of the coronary vessels*

The infarcted area is commonly in the anterior wall of the left ventricle, in the part of the myocardium, that is to say, supplied by the left coronary artery The area is roughly triangular in shape, with the broad base towards the interior of the ventricle It may be red or pale In the early stages it is usually red, becoming pale later on, as necrosis supervenes Ultimately connective tissue develops, and all that is left is a fibrous scar

Owing to the weakening of the muscle at the point of infarction, *aneurysmal dilatation* of the wall may occur, or even sudden, complete *rupture*

Microscopic Appearances —In the early stages the muscle is found infiltrated with red blood corpuscles The muscle fibres are swollen, have lost their transverse striation, and stain deeply The nuclei lose their staining reaction. Later, the area becomes infiltrated with leucocytes and young connective tissue cells The degenerated fibres are absorbed and connective tissue takes their place.

2 *Slow Progressive Narrowing of the Coronary Arteries* —This is due as a rule to *thickening of the intima from atheromatous change* It leads to degenerative changes of a fatty nature in the muscle fibres of the area supplied, and a gradual replacement of these by well-developed fibrous tissue As it is the *anterior or descending branch* of the left coronary artery which is usually the seat of the most marked change, the fibrosis occurs in the wall of the left ventricle near its apex, in the papillary muscles (Fig 17), and in the interventricular septum Owing to the weakening of the heart wall, rupture or aneurysmal dilatation may occur The change produced is precisely the same as that described under *chronic interstitial myocarditis* Indeed, slow progressive narrowing of the branches of the coronary artery is the commonest cause of that condition.

Aneurysm of the Heart.—This is most frequently met with towards the apex of the left ventricle The causation in such cases is usually progressive narrowing of the descending branch of the left coronary artery The connective tissue which takes the place of the degenerating muscle is unable to withstand the pressure within the ventricle The condition may also develop acutely from infarction of the heart muscle or acute myocarditis (Fig 16) On the inner aspect of such dilatations, thrombosis tends to occur An aneurysm of one of the sinuses of Valsalva may also penetrate the heart muscle On the inner aspect of such dilatations the endocardium undergoes fibrous thickening and thrombosis tends to occur

INFLAMMATION OF THE MYOCARDIUM
(MYOCARDITIS)

Types

    1. Acute myocarditis

        (a) Non suppurative, (b) suppurative

    2 Chronic interstitial (fibrous) myocarditis

        (a) Following acute, (b) associated with narrowing
            of the coronary arteries, (c) due to chronic
            inflammatory conditions (tubercle, syphilis)

1 **Acute Myocarditis** —This may be due to (1) *spread of inflammation* from the pericardium or endocardium, or to (2) *blood infection*, as in acute rheumatism, ulcerative endocarditis, pyæmia, etc The muscle substance may show little alteration from the normal It is somewhat soft, friable, pale, and mottled In the special type—*suppurative myocarditis*—small abscesses are seen as minute white points surrounded by zones of congestion and hæmorrhage Very occasionally large abscesses may form which lead to rupture of the heart (Fig 16)

Microscopically the muscle substance is found infiltrated with leucocytes, more especially in the neighbourhood of vessels The leucocytes may be aggregated into large masses, with hæmorrhage around and plugs of cocci in the centre of the abscesses. The muscle fibres themselves show cloudy swelling, or, in the neighbourhood of abscesses, actual necrotic change

2 **Chronic Interstitial Myocarditis** —In this condition there is a *replacement of the muscle substance by fibrous tissue* It may (1) *follow acute myocarditis*, (2) *be associated with narrowing* or *obstruction* of the *coronary artery or its branches*, (3) *occur in connection with chronic inflammatory diseases*, such as tubercle and syphilis *The commonest cause is undoubtedly narrowing of branches of the coronary artery* A

slight degree of the condition is often seen in old age due to the same cause

The condition is usually most marked in the *wall of the left ventricle near the apex* It should also be sought in the *papillary muscles* The muscle substance in these areas is partially replaced by white or grey fibrous strands (Fig 17) The endocardium is often thickened over a corresponding area and thrombosis is frequently associated The condition may give rise to aneurysmal dilatation of the heart wall It follows from the above noted distribution that the dilatation occurs most frequently at the apex of the left ventricle

Microscopically the groups of muscle fibres are found separated from one another by bands of well-developed fibrous tissue The isolated muscle fibres are often unusually large, with large, dark staining nuclei Such may indicate an attempt at hypertrophy Following acute rheumatism especially, *collections of cells are often found* wh ch have been called "Aschoff bodies" These occur more particularly in the posterior wall of the left ventricle near its base They are elongated aggregations of endothelioid cells, some of them very large and conspicuous They often occur in immediate relationship to vessels and may be accompanied by polymorphs and eosinophils Aschoff regards them as being collections of mononuclear wandering cells.

Syphilis of the myocardium is occasionally met with either as gumma formation or as a diffuse interstitial myocarditis associated with arterial disease Some ascribe the more extensive scars, often with aneurysmal distention, to the results of a previous gummatous process Gummata may occur in the interventricular septum and thus implicate the bundle of His

Tuberculosis of the myocardium is also a very rare condition It may be met with as small miliary tubercles

or as large caseous masses   The miliary tubercles appear as
grey translucent spots   They are very rare in the heart, and
if met with usually occur in the pericardium   The caseous
masses are yellow with grey margins   Such are excessively
rare

HYPERTROPHY OF THE HEART

A general hypertrophy of the heart occurs in those, such
as athletes, who constantly over-exert themselves   It also
occurs in pregnancy   Hypertrophy of one or more chambers
of the heart is usually associated with chronic valvular
lesions   Conditions, other than cardiac lesions, associated
with hypertrophy of certain cavities are emphysema and
chronic interstitial disease of the lungs with hypertrophy of
the *right* ventricle, chronic kidney disease, and arteriosclerosis
with hypertrophy of the *left* ventricle (Fig 24)

DILATATION OF THE HEART

General dilatation of the heart is found in association
with degenerative changes, such as cloudy swelling, fibrous
myocarditis, and fatty degeneration   The dilatation is
usually most marked on the right side   In adherent peri
cardium of any marked degree the heart as a whole tends to
dilate

Dilatation of the right side is found as a rule in cases of
death from heart failure   It also occurs in chronic valvular
disease involving the mitral or aortic valve   *Dilatation of
the left ventricle* associated with hypertrophy occurs in a
marked degree in cases of aortic incompetence   Localised
dilatations are known as aneurysms   They are usually met
at the apex of the organ

Tumours of the heart are excessively rare   Primary
tumours such as fibromata or myomata are described

Secondary tumours—sarcomata and carcinomata—occasionally occur, but may involve the heart very extensively before they result in death. The commonest of these secondary involvements is an extension of a mediastinal tumour, usually a sarcoma.

DISEASES OF THE ENDOCARDIUM

DEGENERATIVE CHANGES

Red staining of the endocardium, heart valves, and vessels occurs post mortem as a result of putrefaction processes. It is always marked in cases in which post mortem is performed some days after death. It may also be found soon after death in cases which have died of septic conditions. It is due to the setting free of hæmoglobin from the red blood cells.

Small hæmorrhages may occur under the endocardium in infective conditions and in severe anæmias.

Areas of **fatty degeneration** occur as white specks or patches, more especially in infective conditions, in anæmias, and in cases of phosphorus and chloroform poisoning. These areas occur chiefly on the valves. Under the microscope the protoplasm of the endothelial and of the subjacent connective-tissue cells is found filled with fat globules.

Calcareous and uratic deposits are found more especially in the valves, and chiefly in association with chronic inflammation. They appear as opaque white or yellow areas of thickening, sometimes with a roughened surface, on which thrombi may be deposited.

Atheromatous change both the early stage with thickening of the endocardium and fatty degeneration and the later stage of calcification, may be found, more especially

as an extension from the aorta   There is no hard and fast
line between this condition and the fatty change already
mentioned

Fibrous thickening of the endocardium is common in
relation to chronic endocarditis occurring in the valves
themselves, the endocardium close to the attachments of
valve segments, and in the chordæ tendineæ   Apart from
endocarditis it is met in association with fibrous myocarditis,
aneurysm of the heart wall, and infarction, the area of fibrous
thickening being white and opaque and corresponding in dis-
tribution to the diseased area of heart muscle

CLOTS IN THE HEART

Thrombi are clots formed within the heart or the vessels
during life   In the heart they form chiefly when the blood
current is slow or where there are eddies   These conditions
are present more especially in the auricular appendices
The commonest site for thrombi is the right auricular appendix
(Fig 19)   Thrombi also occur in the ventricles towards the
apex, when they are usually associated with degenerative
changes in the myocardium   They also occur behind the
curtains of the auriculo ventricular valves   They are
frequent on the surfaces of the valves, being known in this
situation as *vegetations*

Thrombi are usually of the mixed red and white type
The colourless portions are opaque white, and more or less
stringy   Thrombi are usually adherent to the heart wall

When thrombi are present in the chambers of the heart
infarcts should be looked for in the various organs   If the
thrombus is on the right side the infarcts will be found in
the lung (except in the rare case of a patent foramen ovale),
if on the left side the infarcts may be in brain, spleen, kidney
or intestine (see Diagram, p 66)

5
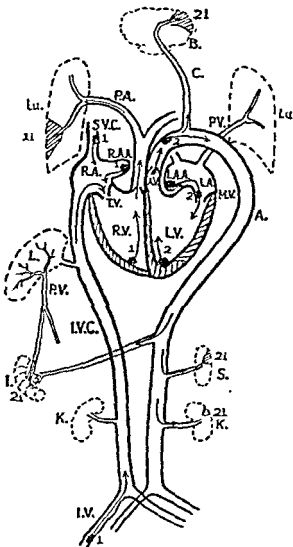
Plan of the Circulation to show the Origin and Destination of the more common Emboli.

1, 2, 3 are thrombi in iliac vein (I.V.) or its branches, e.g. superficial veins of leg; uterine veins, Superior Vena Cava (S.V.C.) or its branches, e.g. cerebral sinuses, right auricular appendix (R.A.A.) and right ventricle (R.V.), which may give rise, by washing away of portions, to infarction in the lungs (Lu.). a, a, are thrombi in left auricular appendix (L.A.A.), on mitral valve (M.V.) or in left ventricle (L.V.) on aortic valve (A.V.) and on wall of aorta (A.), which may give rise, by washing away of particles, to infarction a), b), c) in brain (C.), intestines (S.), kidney (K.). 3 is a thrombosis on radicles of portal vein (P.V.) which might give rise to infarction, or abscess-formation in the liver (L.).

Post mortem clots, on the other hand, are red or yellow, translucent or transparent, jelly like masses which are not adherent Clots often cling to the columnæ carneæ, but they are not really adherent to the heart wall

"Agonal' clots occupy a position between the true thrombi and the post mortem clots They are more opaque than the clots, they may be stringy, but are not adherent They are found more particularly on the right side of the heart, extending up into the pulmonary artery They may completely fill the right auricle and ventricle They are found especially in pneumonia and other infective conditions

Rounded thrombi lying free in the auricles, so-called "ball" thrombi, are sometimes found in cases of stenosis of the mitral valve They, as well as other thrombi in the auricles, often show softening, sometimes liquefaction of their interior (red or simple softening)

(For microscopic appearances of thrombi, see p 94)

	Thrombi.	Agonal Clots.	Post mortem Clots.
Position.	Auricular appendices, valves (vegetations) Apices of ventricles	Mainly right auricle ventricle and pulmonary artery	Anywhere but chiefly on right side
Appearances.	Opaque white, buff coloured or red	Semi opaque Often fill cavity	Transparent
Consistence	Stringy, friable some times softened in centre	Soft and gelatinous	
Relations to heart walls	Adherent When broken off, leaving portions behind.	Non-adherent May cling to columnæ carneæ, chordæ tendineæ, etc	
Associated diseased conditions	Chronic valvular disease of heart Chronic interstitial myocarditis Aneurysm of heart wall	Infective conditions such as acute lobar pneumonia, pyæmia, septicæmia	

INFLAMMATION OF THE ENDOCARDIUM
(ENDOCARDITIS)

The endocardium possesses no direct blood supply, and the heart valves very little This fact in all probability accounts for the rarity of inflammatory phenomena in the ordinary sense of the term in connection with these structures On the other hand, the intimate connection between endocardium and valves and the circulating blood renders these structures peculiarly susceptible to the action of germs or poisons which may be present in the blood-stream Once the endocardium is damaged, thrombosis tends to occur upon the injured surface, with the formation of what are called vegetations. Another fact in the production of the more chronic types of endocarditis is strain Thus the valves of a dilated and powerfully acting heart tend to become thickened.

Types

   1 Acute endocarditis
      (a) Simple or vegetative
      (b) Ulcerative, malignant, or infective
   2 Chronic endocarditis
      (a) Following acute
      (b) Associated with atheroma.
      (c) Associated with strain

   1 **Acute Endocarditis.**—This condition is probably in variably due to the presence of germs upon the endocardium Two sub-varieties are distinguished (a) *simple* or *vegetative*, and (b) *ulcerative* or *malignant* There is no hard-and-fast line between these two They are both due to the presence of germs, and may be due to the same germs The simple type, however, has a very constant relationship to acute rheumatism, and is thus caused probably by the *micrococcus rheumaticus* The malignant type may be caused by a variety of germs, such as *pneumococcus, streptococci, staphylococci, gorococcus*

In both varieties the essential change is the presence on the damaged valve of vegetations or thrombi, and, as stated above, no hard and fast line can be drawn between the two conditions In deciding in any case as to which condition is present the following points should be attended to (1) *Character of vegetations* These in the ulcerative type tend to be larger and more friable (2) *Extent* In simple endocarditis the vegetations are limited to a line close to the free margin of the valve, in ulcerative endocarditis they extend not merely all over the valve but on to the surface of auricle in the case of mitral disease, on to aorta or heart wall in the case of aortic disease, also in the case of the mitral valve they extend on to the chordæ tendineæ (3) *Effect on valves* In the case of simple endocarditis beyond swelling of the valve no special change is observed In the ulcerative type destruction of the valve, aneurysm or rupture of the valve or of the chordæ tendineæ is often met with As regards the site, both varieties are found much more commonly on the left side of the heart When endocarditis occurs during fœtal life it is found more frequently on the right side

(a) **Simple Acute Endocarditis** —This is usually met in connection with the mitral and aortic valves, more rarely on tricuspid or pulmonary valves It is most commonly associated with acute rheumatism, but may be found in cases of tonsillitis, chorea, scarlet fever, and septicæmia The valves themselves are somewhat swollen, and on the segments is a fringe consisting of larger or smaller numbers of warty projections (vegetations) (Figs 20 and 21) These vegetations are found not at the free margin but on a line a short distance from that margin In the case of the mitral valve they are to be found on the upper or auricular surface, in the case of the aortic valve on the lower or ventricular. The line on which they occur is that of

maximum pressure of the valves during closure The
vegetations may be soft, friable, and easily removed, or firm
and adherent Infarcts are frequently found in such organs
as spleen and kidney

Microscopic Appearances —The various cellular and fibrous
elements in the valve are separated from one another owing
to œdema. There may be fibrin present in the connective-
tissue spaces, and usually polymorphonuclear leucocytes and
young connective tissue cells and other wandering cells are
found, in addition to the fixed tissue elements On the surface
of the valve there is a mass of granular material staining
with acid dyes, and consisting of blood platelets and fibrin.
In addition there may be fibrin threads There are usually
numerous white blood corpuscles which are found in groups
Red cells may be present at the free margin, and masses of
germs can be demonstrated by suitable methods in some cases
In the later stages evidence of organisation may be found at
the junction of valve and thrombus Spindle shaped and
rounded cells may be seen making their way in from the valve
to the vegetation. These are fibroblasts resulting from the
division of the connective tissue cells of the valve

(b) **Ulcerative Infective Endocarditis.**—In this type
the valve may present the same appearance of slight swelling
It is *often thickened* from previous endocarditis The vegeta
tions tend to be larger and more friable They are *not limited
to the margin of the valve* but extend on to auricle or *chordæ
tendineæ* (Fig 22), ventricle, or aorta There may be *destruc
tion of the valve substance* with ulceration, *aneurysmal dilation*
of a segment, or *complete rupture* (Fig 23) Rupture of such
structures as *chordæ tendineæ* also occurs Owing to the
greater friability there is an *increased tendency to embolism*
and *infarction* Also the infarcts may be septic In ulcera
tive endocarditis the valve often shows fibrous thickening
due to previous simple endocarditis In other words, the
acute, as also the subacute ulcerative type, tends to
occur in a valve which has already been the seat of endo-
carditis

Microscopically, the infiltration of the valve with inflammatory cells is more marked The other appearances are the same, except that masses of micro organisms tend to be larger and more numerous Actual destruction of the valve substance may be found.

(*c*) **Subacute Endocarditis** —This is a term recently introduced to characterise a clinical condition It is always an *ulcerative type of endocarditis lasting many weeks or months*

	Simple or Vegetative.	Malignant or Ulcerative.
Character of vegetations	Small, firm	Large, friable
Extent	Limited to line close to free margin of valve	Tendency to extend to wall of auricle, and ventricle, to chordæ tendineæ, aorta, etc
Appearance of valves	Very little alteration, slight swelling	Destruction of valve, aneurysm formation, rupture of valve or chordæ tendineæ Valve often already thickened from previous acute endocarditis.
Associated conditions	Chorea, acute rheumatism, scarlet fever, infarcts in spleen, etc	Pyæmia, greater tendency to formation of infarcts and embolic abscesses, also acute aneurysms.
Causal organism	*Micrococcus rheumaticus,* found in many cases	*Pneumococcus, Gonococcus, Staphylococci, Streptococci,* especially *Streptococcus hæmolyticus* and *S viridans*

in which the valves are already the seat of fibrosis from previous endocarditis The vegetations show the characters and appearances of those in ulcerative endocarditis Embolism of vessels and infarction are common, and acute aneurysm, often of the superior mesenteric artery, is met with due to the blocking of the vessel by an infective embolus and the subsequent weakening of the wall from inflammatory change The causal germ in these cases is usually a streptococcus, often *Streptococcus viridans* This is a non-hæmolytic type of streptococcus which develops green colouration on blood agar medium owing to the production of methæmoglobin It has a relatively low pathogenicity, hence the slow progress of the disease and the chronic character of the lesions produced It can usually be cultivated from the blood in cases of subacute endocarditis, and it is usually present in immense numbers in the vegetations and the metastatic lesion It is also found as a pathogenic agent in cases of tonsillitis, otitis media, and dental abscess.

Results of Acute Endocarditis.

(a) The conditions may return to the normal, the inflammatory exudate and vegetations being absorbed

(b) The proliferated connective tissue cells may settle down and form new connective tissue, vessels at the same time penetrating the valve from the nearest vascular area. The new connective tissue shrinks and the valve remains permanently thickened and altered In other words what is called *chronic endocarditis* supervenes This very frequently happens with resulting stenosis or incompetence of the valve

(c) A second attack is not infrequent when a valve has once been the seat of inflammatory change As already stated, the ulcerative type tends specially to occur in the case of valves already damaged

(d) Embolism, infarction, and acute aneurysms in situations such as the mesenteric vessels, due to blocking of

branches of the systemic arteries, are very commonly met with, more especially in the case of the ulcerative type of the disease

2 **Chronic Endocarditis** —This condition may (1) *follow an acute endocarditis* owing to organisation and subsequent laying down of new connective tissue, (2) *arise slowly* owing to the action of chronically acting poisons, such as lead, alcohol, syphilis, retained products of metabolism (gout), or (3) it may be due to *strain* Chronic thickening of the endocardium lining the cavities of the heart occurs sometimes when the cavities are the seat of chronic dilatation

The valve which is the seat of this change is thickened The thickening may be chiefly at the line of attachment, may be near the margin, or may occur throughout The valve is thus opaque and white or yellow in colour The segments are usually shrunken, misshapen and may be united together so that the orifice is narrowed (Figs 26 and 27) Such thickened valves are often the seat of calcareous deposits which appear as more opaque, yellow masses in the substance of the valve Sometimes the endocardium over the calcareous deposit necroses from want of nourishment, and so thrombus formation may take place upon the calcareous surface laid bare

Microscopically such valves may show little beyond an amount of well developed fibrous tissue greater than usual Hyaline degeneration may take place in this connective tissue, also calcareous deposit.

Results of Chronic Endocarditis —The chief results are (1) *Narrowing of the valve* from adhesion between its segments, contraction of its fibrous elements, or from both causes (stenosis) (2) *Failure of the valve to perform its function of closure* of the orifice, due to shrinkage and contraction of its segments (incompetence) In consequence of these two results of the changes in the valves themselves or

extensive series of alterations may take place in the various chambers of the heart and in the circulation generally The diseased condition of the valves, with the accompanying changes in the circulation, is generally known as *chronic valvular disease of the heart* According to the valve affected and the type of the lesion, different varieties are distinguished

EFFECT ON THE HEART AND CIRCULATION OF THE DIFFERENT TYPES OF CHRONIC VALVULAR DISEASE

1 **Mitral Stenosis.**—This is perhaps the best defined type of chronic valvular disease It is found chiefly in women, and is due invariably to the adhesion, shrinking, and contraction of the two segments of the mitral valve following acute endocarditis of the valve, very often of rheumatic origin The valve is thickened, opaque, the segments are united together, and the opening may be a slit and nearly flush with the attachment of the valve (buttonhole mitral) (Fig 26), or more or less circular and some distance below the level of the attachment of the segments (funnel shaped mitral) The amount of narrowing varies in different cases Occasionally the contraction is so marked that the valve will not admit the tip of the finger, scarcely a crow quill

The process of narrowing occurs slowly, so that the effect is only gradually felt by the heart This being the case, the left auricle, upon which the strain falls, gradually dilates and its wall thickens in order to overcome the obstruction For a time the hypertrophied *left auricle* may be equal *to* the task of driving the blood through the narrowed orifice Eventually, however, the tendency is for the backward pressure to tell upon the pulmonary circulation, so that the lungs show chronic venous congestion Not infrequently the pulmonary artery exhibits in this condition well marked

patches of fatty change (atheroma) Through the lungs the pressure tells back upon the right side of the heart, the cavities of which become dilated and their walls thickened (Fig 25) At the same time the backward pressure tells upon the whole venous system, with the result that chronic venous congestion develops in all the organs and viscera, including the heart, as well as in the tissues and limbs The degree of this congestion depends upon the capacity of the heart to respond to the demands made upon it When the heart fails to respond, or, as it is usually expressed, when com pensation fails, the congestion becomes extreme, and œdema or dropsy tends to appear, more especially in the tissues of the lower limbs

The left ventricle in mitral stenosis tends to receive less blood than usual Its work is not necessarily interfered with In consequence, it either does not enlarge or it may even become smaller A degree of incompetence of the valve is usually present in mitral stenosis, especially in advanced cases owing to stiffness of the segments In cases where the incompetence is marked the left ventricle will tend to dilate

2 Mitral Incompetence —This lesion may occur alone, or it may be combined with a degree of narrowing It may be associated with thickening and contraction of the valves from a previous acute attack of endocarditis, or, on the other hand, the incompetence of the valve may be merely relative, due to a lax or stretched condition of the band of circular muscle fibres which surround the base of the valve and assist in its closure, or due to dilatation of the ventricle carrying outward the attached papillary muscles In appear ance the valves are usually thickened, shrunken, and con tracted towards their attachment Not infrequently the chordæ tendineæ are also thickened and shortened The lesion is associated with dilatation and hypertrophy of the

left ventricle, then of the left auricle The lungs become congested, and through the lungs the pressure tells back upon the right side of the heart. Thus the heart in this condition tends to undergo more or less uniform enlargement

3 Aortic Incompetence —This condition is due to thickening and shrinking of the segments of the aortic valve. It is often associated with a degree of stenosis The cause may be (a) a previous acute endocarditis of the aortic valve which is not infrequently associated with endocarditis of the mitral valve , (b) the spread of disease (atheromatous or syphilitic) from the aorta, (c) occasionally it may be due to traumatic rupture of a segment which, however, is usually already the seat of chronic changes, (d) very rarely it is caused by congenital malformation or fœtal disease The condition occurs most commonly in men and in later life

In consequence of the failure of the segments to close the orifice during diastole, blood flows backwards again into the left ventricle from the aorta. The cavity has thus to accommodate this blood in addition to what comes normally through the mitral orifice The left ventricle therefore dilates At the same time the wall of the cavity hypertrophies in order to drive on the large quantity of blood. This dilatation and hypertrophy of the left ventricle is often very great. The largest hearts on record are from cases of aortic incompetence The term *cor bovinum* has been applied to them. Subsequently, owing to the great dilatation of the left ventricle, a relative incompetence of the mitral valve may be brought about. Thus there is backward pressure on the left auricle, then on the lungs and the right heart. Owing to the injection of the blood into the aorta by the powerfully acting left ventricle, aneurysmal dilatation of the aorta may occur, more especially as the vessel is frequently the seat of disease Owing to the rapid emptying of the arteries, those going to the head are badly supplied

with blood Hence the marked pallor of individuals suffer ing from this condition, and hence the tendency to fatal syncope

4 **Aortic Stenosis** —This is usually accompanied by more or less incompetence The cause may be a previous attack of acute endocarditis, or it may be associated with atheroma of the aorta The segments of the valve are thickened and often the seat of calcareous change They are usually united together, sometimes leaving only a minute aperture for the passage of the blood (Fig 27) The effect upon the heart is to cause hypertrophy of the left ventricle, which is usually at the same time dilated, owing to the exist ence of a certain amount of incompetence

5 **Tricuspid incompetence** is the commonest valvular lesion on the right side of the heart, and is most commonly merely relative, due to a dilated condition of the right ventricle It is more rarely due to endocarditis, either during extrauterine or fœtal life It leads to dilatation and some hypertrophy of the right auricle, and is associated with marked venous engorgement, and often with pulsation in the veins of the neck and in the liver

6 **Tricuspid stenosis** is a rare condition by itself It is usually associated with stenosis of the mitral valve It is due to endocarditis occurring either during fœtal or extrauterine life

7 **Lesions of the pulmonary valve** are very rare, and are usually congenital, being due either to malformation or fœtal endocarditis

ŒDEMA OR DROPSY IN CARDIAC DISEASE

When the heart is failing from degenerative changes in its musculature or from dilatation associated with chronic valvular disease, œdema tends to appear Cardiac œdema is usually distributed about the body in accordance with the

effect of gravity, appearing first and being most marked in the more dependent parts, such as the tissue round the ankles Later on it spreads to other parts and to the serous sacs—peritoneum, pleura, pericardium As regards the causation of this type of œdema, increased pressure within the capillaries from venous congestion is certainly an important factor Experimentally produced *venous obstruction is*, however, not necessarily followed by dropsy Another factor must be presupposed This factor is the damage to the endothelium due to defective nutrition of the cells from mal-oxygenation of the blood and retention of waste products At the same time there is also obstruction to the lymphatic return owing to the fact that the larger lymph channels open into veins over-distended with blood

PRIMITIVE MUSCULAR TISSUE OF THE HEART AND ITS RELATION TO "HEART BLOCK"

There are two main portions of primitive muscular tissue which should be examined —

(1) The *sino-auricular node*, the site of origin of the normal stimuli for the heart's contraction which is situated between the opening of the superior vena cava and the right auricular appendix It is composed of slender muscle fibres, nerve-cells and fibres It has been found to show subacute and chronic inflammatory change in cases of arrhythmia.

(2) The *auriculo-ventricular bundle*, which starts from the auriculo ventricular node, situated on the right side of the inter-auricular septum in front of the opening of the coronary sinus, and above the attachment of the septal cusp of the tricuspid valve. The *auriculo-ventricular node* consists of tissue similar to the sino-auricular node. From the node the bundle runs forward almost horizontally, but somewhat downwards, and usually to the left in the pars membranacea septi At the anterior part of the membrane, a little in front of the anterior end of the attachment of the median and septal segments of the tricuspid valve, the bundle divides into two parts The left division passes downwards and perforates the

membrane, entering the subendocardial tissue of the left ventricle at a point immediately beneath the union of the anterior and right posterior cusps of the aortic valve   It then spreads out in a fan shaped fashion under the endocardium of the left side of the septum, going to the papillary muscles of the mitral valve and the ventricular muscle.   The right branch of the bundle passes down the right side of the septum and is distributed to the papillary muscles and wall of the right ventricle   The bundle is responsible for the conduction of the impulse from auricle to ventricle.

In cases of "heart block ' the bundle has been found implicated or destroyed in some part of its course.   The lesions found have been (1) Acute inflammation from spread of ulcerative endocarditis of mitral or aortic valve, (2) chronic interstitial myocarditis and sometimes calcification associated with arteriosclerosis of the coronary artery, (3) fibrosis following acute rheumatic inflammation of myocardium, (4) fatty infiltration, (5) tumour formation, e g sarcoma, (6) gumma of heart wall, (7) aneurysm of one of the sinuses of Valsalva involving the septum.

GENERAL METHOD OF SETTING ABOUT THE EXAMINA-
TION OF A HEART WHICH IS BEEN EXCISED AND
OPENED UP

Note in the first instance the size of the organ   A rough approximation to the normal size of a heart is obtained by comparing it with the closed fist of the individual.   Next note the shape   The normal heart is conical.   This shape is retained when the heart is enlarged, if that enlargement be due to uniform increase in size of all the cavities   If, however, the left ventricle be hypertrophied (as in kidney and arterial disease) out of proportion to the rest, although still conical the organ is elongated.   In cases where the right side of the heart is enlarged out of proportion to the left, as in mitral stenosis and in chronic pulmonary disease, the organ, instead of being conical, is ovoid (Fig 15)

Next examine the visceral pericardium for milk spots, petechial hæmorrhages, fibrinous exudate, adhesions to the pericardial sac.   Then turn to the right side and examine the right auricle as to its size, the thickness of its walls, its contents (looking more especially for thrombi in the appendix)

Next examine the right ventricle as to its size, the thickness of the walls, the amount of fat in the subpericardial tissue, and whether this fat is actually invading the muscle substance. Estimate the diameter of the tricuspid valve and examine its segments for thickening and vegetations. The diameter may be measured roughly with the fingers. The opening normally admits three digits. Glance at the pulmonary valve for the presence of thickening and vegetations.

Now turn the heart round and examine the left auricle as to size, thickness of walls, thickening of the endocardium, the presence of vegetations or thrombi (more especially in the auricle). Examine the left ventricle as to its size, the thickness of its walls, the appearance of the cut surface of the muscle. Note the colour of the muscle. Look for fatty change, more especially in the papillary muscles, for fibrous tissue (indicating the existence of chronic interstitial myocardius), more particularly towards the apex of the ventricle, in the interventricular septum, and in the incised papillary muscles. Estimate the consistence of the muscle by testing its friability.

Now examine the mitral valve as to its diameter. The opening normally admits two digits. Estimate the thickening of the segments and of the chordæ tendineæ, for vegetations on its surface or fatty change in the endothelium.

Then turn to the aortic valve, estimate its circumference. Look for thickening, calcification, vegetations. Examine the portion of the aorta most attached for atheroma. Lastly, look at both coronary arteries, more especially the left, for the presence of dilatation or narrowing, for fatty or calcareous atheroma, and for thrombosis.

HEART WEIGHTS AND MEASUREMENTS

Weight, 9-13 oz. (250-370 grammes).
Length of left ventricle, 3 3/4 in. (7 6-8 4 cm.).
Thickness of wall of left ventricle, 1/4 in. (at thinnest) to 4/5 in. (6·1-2 cm.).
Length of right ventricle, 3 1/10 to 3 3/8 in. (7 8-8 6 cm.).
Thickness of wall of right ventricle, 1/8 in. (0 32 cm.).

DIAMETERS AND CIRCUMFERENCES OF THE HEART VALVES
(Shennan)

			Diameters.	Circumferences.
Tricuspid	•	•	•	ins cm	1 5 to 1 8 3 8 to 4 7	4 5 to 5 5 11 4 to 14 0
Pulmonary	•	,	•	ins cm	1 1 to 1 2 2 8 to 3 0	3 4 to 3 7 8 6 to 9 5
Mitral	•	•	•	ins cm	1 2 to 1 4 3 0 to 3 5	3 7 to 4 4 9 5 to 11 0
Aortic	•	•	•	ins cm	0 9 to 1 0 2 3 to 2 5	2 8 to 3 2 7 2 to 8 0

CHAPTER V

DISEASES OF THE VESSELS

THESE may be divided into (A) Diseases of the Arteries, (B) Diseases of the Veins

A DISEASES OF THE ARTERIES

In all cases of sudden death the arteries of the internal organs should be slit up and carefully examined for the presence of impacted emboli More particularly is this the case with the pulmonary and coronary arteries

In cases of senile gangrene the vessels of the affected limb should be opened up and thrombi or impacted emboli sought for

Amyloid or Waxy Degeneration.—This is a condition which usually starts in the arterioles, particularly those of the internal organs—spleen, kidney, liver, intestine—and spreads forwards to the capillaries and backwards to the larger vessels In the case of the medium-sized vessels the change occurs in the middle coat, affecting the bands of connective tissue which lie between the circular muscle fibres The condition is only found on microscopic examination, although by means of iodine, when advanced, it may be made visible to the naked eye With iodine the affected area gives a mahogany brown colour Amyloid degeneration

should be looked for especially in (1) advanced tuberculosis, (2) visceral syphilis, (3) chronic suppuration, *e g* long-existent empyema, bone disease, etc

Fatty Degeneration of the Intima — This may be seen, more particularly in the aorta, in the form of pale yellow streaks or patches often arranged in the long axis of the vessel It is associated with anæmia and toxæmias

Microscopically, the fatty change is found in the endothelial cells and in the subendothelial connective tissue

Calcareous Degeneration of the Media — This is a change found chiefly in old age It may be preceded by fatty or hyaline change, and it affects the medium sized arteries, such as the femoral, brachial, and radial The arteries which are the seat of the change are hard and brittle and show a transverse striping very noticeable to the naked eye Such calcareous change is often found in organs under going atrophy from disuse or senile change Thus it is frequent in the vessels of the uterus in old age and is some-times also found in the thyroid gland in myxœdema The calcareous deposit is easily recognised under the microscope in specimens stained with hæmatoxylin and eosin by the dark purple colour which the inorganic material assumes The condition is usually known as Monckeberg's degeneration

Acute Inflammation — This may occur in the first part of the aorta due to extension of inflammation from aortic endocarditis of the ulcerative form It may occur in arteries passing through areas which are the seat of acute inflam matory change More frequently it is caused by the impaction of an embolus containing germs, which sets up inflammation in the wall of the vessel and may lead to the formation of an acute aneurysm, *e g* in a branch of the pulmonary artery, superior mesenteric artery, etc.

ARTERIOSCLEROSIS

Arteriosclerosis, or hardening of the arteries, is an exceedingly common condition, and as defined includes a number of diseases of somewhat different nature and origin The calcareous degeneration of the media already mentioned is one type Another type is endarteritis deformans, atheroma, or, as it has more recently been called, atherosclerosis Another type is syphilitic disease of arteries Lastly, there is hypertrophy of the middle coat of the medium sized and smaller vessels

Types of arteriosclerosis

1 Atheroma, atherosclerosis, endarteritis deformans
2 Hypertrophy of the media
3 Endarteritis obliterans
4 Calcareous degeneration of the media (see above)
5 Periarteritis nodosa.

Atheroma (Gr. αθηρη, porridge), Atherosclerosis, Endarteritis Deformans

A *nodular* and a *diffuse* form of the condition are sometimes distinguished, the former affecting the aorta, the coronary, pulmonary, and cerebral arteries, the latter more associated with the medium-sized and smaller vessels, such as the renal and its branches, the radial, and sometimes the coronary and cerebral The nodular form is, however, not infrequently found in the smaller vessels mentioned

In the aorta the condition appears first as streaks or patches of a grey or pearly white appearance, slightly raised above the surface, and due to *thickening of the intima* These patches occur especially round the openings where smaller branches, such as the intercostals, leave the main trunk, also in the arch of the aorta. Very early in their formation they become opaque and yellow in colour owing to *fatty*

change The patches gradually increase in size, and eventually become the seat of a *calcareous deposit*, thus forming hard brittle plates in the intima of the vessel (Fig 28) The intima then tends to degenerate and disappear, leaving a cavity, the floor of which is formed of pulpy necrotic material—the atheromatous *ulcer* *Thrombosis* may occur on the diseased area even before the formation of the ulcer There is an increased tendency to it after the ulcer has developed When well marked, the change is often found throughout the entire length of the aorta—thoracic and abdominal It tends to be more advanced *in the arch* and in the *lower part of the abdominal aorta* just before it bifurcates Similar changes are to be seen in the larger branches and in the medium sized vessels, such as coronaries, cerebrals, etc The patchy character of the disease is often particularly well seen in the vessels of the brain (Fig 29), where, owing to their transparency, the yellow areas can be seen even in the smaller branches In these medium sized and smaller vessels, such as cerebral and coronary, the thickening of the intima often leads to very marked narrowing of the lumen

A *special type of atheroma*, termed *syphilitic*, may be distinguished It is frequently combined with true atheroma. In position, however it is found especially in the *first part of the aorta*, often spreading to and involving the segments of the aortic valve, thus leading to aortic incompetence Whereas atheroma is a disease of more advanced age, this type is often found in comparatively young people It may not always be syphilitic in origin, but in many cases it undoubtedly is so, spirochætes having been found in the lesions in the vessel wall This type is char acterised by the formation of *large, white, raised, semi trans lucent or opaque white patches* There is *not the same tendency to fatty and calcareous change*, so that the patches remain white and there is no formation of atheromatous ulcers *Puckering* not infrequently occurs in the centres of these areas *Dilatation* and aneurysm formation is common

Effects of Atheroma

(1) Loss of power of the vessel to dilate and contract.

(2) Narrowing of lumen of vessel, with tendency to degenerative changes in organ or tissue supplied, with replacement of functioning cells by fibrous tissue. In kidney—chronic interstitial nephritis; in heart—chronic interstitial myocarditis

(3) As a result of narrowing of the lumen there is increased difficulty in driving the blood along, hence hypertrophy of the left ventricle occurs

(4) Weakening of the wall, with tendency to dilate at some point and form an aneurysm *with tendency also to rupture*

(5) Tendency to thrombosis on the diseased areas, with consequent tendency to embolism

Microscopically, the earliest change is found to be a proliferation of the subendothelial connective tissue cells. This leads to a thickening of the intima formed of layers of rounded and spindle shaped connective tissue cells with intercellular fibrils. Owing to the fact that the nourishment of the intima and of the inner portion of the media is obtained from the blood circulating within the vessel itself, the deeper portions of the thickened intima undergo fatty, and eventually calcareous, change. Fatty globules and crystals of fatty acids are found in the degenerated area, also granules of calcium salts. Changes are also to be observed in the internal elastic lamina. It splits into fine fibrils and becomes fragmented. This damage to the internal elastic lamina is regarded generally as the primary change. The media may also show fatty degeneration, owing to interference with its nourishment. It not infrequently gives way, and the vessel becomes dilated.

In the case of the aorta the changes in the media may be more marked. There may be invasion of vessels from the vasa vasorum into the media, and around these vessels there are numerous round cells.

In the syphilitic type, in addition to the greatly thickened intima composed of layers of well formed fibrous tissue without

fatty or calcareous change, there is marked change in the media. This takes the form of an invasion of the media by vessels accompanied by connective tissue   This results in a replacement of the media by fibrous scar tissue, the contraction of which causes the puckerings

Causation.—During the first twenty years of life there is a progressive thickening of the coats of the vessels with a progressive development of elastic tissue   For the next twenty years of life approximately things remain stationary. After that there is a progressive deterioration in the elastic
⸱ tissue, with consequent weakening of the vessel wall   In certain individuals the elastic tissue of the vessels is congenitally deficient   Atheroma is a disease which develops at the time of life when the vessels are beginning to deteriorate, but the individual is at the height of his physical activities.   High blood pressure from bodily exertion, combined with degenerat ing elastic tissue, are the two main factors in the disease. Sometimes the one sometimes the other is the more prominent. That high pressure of itse'f can produce the condition is proved by the experimental work on animals   By the administration of doses of adrenalin over periods of weeks and months, thus causing contraction of the vessels and raising the blood pressure, it has been found possible to produce changes in the vessels of rabbits analogous to atheroma in the human subject.   The same thing has been effected by holding the animal up by the hind legs for a few minutes every day for some weeks   In this way well marked degenerative changes very similar to human atheroma have been produced in the vessels above the diaphragm

Infective conditions such as syphilis, typhoid fever, etc., act by causing proliferative changes of an inflammatory nature in the intima.   As a result there is malnutrition of the vessel wall subjacent to the thickened area with consequent degenerative changes

In the human subject toxic conditions associated with high blood pressure, such as renal disease, lead poisoning, gout, alcoholic poisoning, are also factors in the production of the disease.   At the same time, infective conditions such as syphilis cannot be ignored

As to the nature of the primary change, this is generally regarded as being a fragmentation and fibrillation of the

internal elastic lamina. Subsequent to th s, and with a view to repairing the damage, there is a prol feration of the cells of the intima, with resultant thickening. Owing to the fact that the intima and outer port on of the media obta n their nourishment from the b od flowing in the vessel itself, the deeper portion of this new tissue and the adjacent media undergo degeneration of a fatty nature. The fatty acids which are formed are believed to combine with alkalies to form soaps. Among these soaps are calcium combinat ons. The fatty acid is rejected by the calcium in favour of carbonic and phosphoric acid, with resulting deposition of calcium carbonate and phosphate in a granular form.

Summary of Causes of Atheroma

(1) Old age
(2) Congenital deficiency in elastic tissue of vessels.
(3) Strain.
(4) Chronic toxæm as—alcohol, gout.
(5) Infective condit ons—syphilis, typhoid, etc.

Hypertrophy of the Media.

This is another form of arterio-sclerosis due to contrac tion under prolonged stimulation by the influence of toxic substances circulating within the vessel It is very character istically associated with the subacute and chronic forms of Bright's disease. The condition affects the medium-sized and smaller vessels The hypertrophy of the muscular coat is followed by a fibrous transformation

Endarteritis Obliterans or Proliferans

This is a type of arterial disease associated w th thickening of the intima in which there is no tendency to degenerative change, as in atheroma The reason is that the new tissue laid down within the internal elastic lamina carries with it its own blood vessels This tissue is, in other words, granulation tissue The condition is found associated with all types of chronic inflammation, e g tuberculosis, syphilis, leprosy. It is usually regarded as being specially sign ficant of the

presence of syphilitic disease, but it is just as frequent in tuberculosis It is found in the vessels in the neighbourhood of syphilitic gummata and in vessels in the lung, bones and joints in tuberculosis Sometimes it occurs in the vessels of the brain in syphilis, thrombosis in these vessels in early life being a not infrequent cause of cerebral paralysis In the lung in tuberculosis the change is a most beneficial one, as the tendency to rupture of vessels in the neighbourhood of cavities is thereby greatly diminished It is probable that the atrophy of limbs in tuberculous joint and bone affections may in part be explained by malnutrition following diminution in size of lumen of the nourishing vessels As might be anticipated, the change is often accompanied by inflammation of the other coats of the vessel, more especially the adventitia

Microscopically, the condition is characterised by the laying down of layers of new tissue within the internal elastic lamina. At first the tissue is cellular, later on it becomes well developed connective tissue. Very often new layers of elastic tissue are formed, and sometimes there are several small vessels within the compass of the original vessel wall. In addition, there are inflammatory changes in media and adventitia, more especially the latter

Arterial Disease in Syphilis — Syphilis affects the arteries in several ways It is one of the infective conditions leading to *atheroma,* more especially in that type called syphilitic, where the aorta is the seat of formation of raised, white, semi translucent areas with a tendency to puckering

Another type of lesion found more especially in the smaller arteries is the above mentioned *endarteritis obliterans,* with accompanying periarteritis

Syphilitic disease of vessels is a frequent cause of aneurysm formation and of thrombosis

Arterial Disease in Tuberculosis —Tuberculous disease has a marked tendency to spread by the perivascular lymph

atics, and thus has from the commencement an intimate association with vessels This condition of periarteritis leads to a thickening of the vessel The process may spread inwards and produce an *endarteritis* Sometimes a tuber culous focus may burst its way through a vessel wall, thus giving rise to a general *blood infection*

This endarteritis is found in a marked degree in all cases of chronic pulmonary tuberculosis It is also found in the smaller vessels in the neighbourhood of tuberculous lesions of bones and joints As in syphilis the thickened intima shows no tendency to degeneration in its deeper parts

The inflammatory change in the vessel walls in the neighbourhood of cavities may lead to weakening, *aneurysm* formation, or rupture As previously stated, it more frequently causes more or less complete obliteration

Aneurysm

An aneurysm is a localised enlargement of the lumen of an artery The enlargement may involve the whole lumen for a short distance (*fusiform aneurysm*), or it may be a diverticulum from one side of the vessel (*saccular aneurysm*) (Fig 31)

The term *acute aneurysm* is applied to any rapid dilatation of an artery through an inflammatory process in its wall, usually due to the presence of a septic thrombus within its lumen A *false aneurysm* is an accumulation of blood communicating with a vessel and surrounded, not by the vessel wall, but by a condensation of tissue in the neighbourhood A *dissecting aneurysm* is a condition, found usually in the aorta, where the blood finds its way, commonly by a split in a calcareous atheromatous patch between the intima and media, or between media and adventitia, or again between two layers of media Sometimes the blood finds its way back again at a different level into the lumen The term *miliary*

aneurysm is applied to minute dilatations, usually of a saccular type, occurring on the course of the smaller cerebral arteries

The most common *site* for aneurysm is the thoracic aorta—the ascending portion, the arch or descending portion The next most common site is the abdominal aorta, then come the popliteal and carotid arteries The special type, miliary aneurysm, is found in the cerebral vessels Aneurysms also occur in the branches of the pulmonary artery in the neighbourhood of tuberculous cavities (Fig 52), and as the result of septic embolism

Aneurysms vary greatly in size and shape The cavity may be largely filled with white and red thrombus, often with a laminated appearance This thrombus is seldom the seat of organisation The wall may be formed of all the coats of the vessel Usually, however, the intima, if present at all, is in patches This, no doubt, is the explanation of the non-occurrence of organisation in the thrombus contents The media may also disappear and the wall be formed only of adventitia and condensed connective tissue surrounding Occasionally the wall is partly formed of bony structures such as the vertebræ (Fig 31) The wall of the vessel in the neighbourhood is usually the seat of atheromatous change, frequently of the syphilitic type

Changes produced in Surrounding Parts —These depend upon the position of the aneurysm The dilating vessel presses upon viscera, such as trachea, bronchi œsophagus, upon nerves and vessels Thus irritation or paralysis of nerves—recurrent laryngeal, trunks of the brachial plexus—results Pressure on trachea and bronchi leads to accumulation of secretion, and sometimes to gangrene of the lung, also to erosion and rupture Pressure on œsophagus similarly causes obstruction, and may result in rupture Bones such as sternum and vertebræ are eroded, also cartilage but the softer the tissue the better it resists, so that intervertebral

discs may project beyond the harder bone. *Pressure upon lung leads to collapse and atrophy*

Smaller vessels arising from the aneurysmal portion of the vessel tend to be contorted, and sometimes their lumen obstructed by thrombus The heart may be displaced downwards, *and may be hypertrophied*

Rupture may occur *through the skin* in thoracic aneurysm projecting forwards into the *trachea, bronchi, œsophagus, pericardial sac, pulmonary artery* In the case of cerebral aneurysms, into the brain substance or under the membranes, in phthisical aneurysms, into the lung cavity, with consequent hæmoptysis

Causation —Two factors are concerned in the causation

(1) Conditions which lead to weakening of the vessel wall, (a) injury as from a gunshot wound, (b) disease, such as (i.) acute arteritis from inflammation around the vessel or from impaction of a septic embolus in the vessel, (ii.) chronic arteritis from atheroma, more especially the syphilitic type

(2) Conditions leading to sudden rise of blood pressure, e g lifting of heavy weights

The condition is far more frequent in males than in females (out of 189 cases, 171 males) It occurs as a rule above forty years of age, i e at the period when the vessels are beginning to degenerate while the individual is still in active work. In something over 50 per cent of cases a history of syphilis may be obtained

Periarteritis Nodosa. —This is a very rare disease, only some 50 cases having been described up to date in medical literature It is usually met in males and is more frequent in the adult It is seldom diagnosed during life, the case being simply one of progressive weakness and wasting with fever, although hard bead like swellings may sometimes be recognised in the skin of the thorax and abdomen due to nodular thickenings on the subcutaneous arteries. Post mortem, these nodes, which are usually the size of a pea or under, are found along the course of the vessels of the internal

organs such as heart, liver, kidneys, spleen, mesentery, pancreas, and sometimes brain   Infarctions in heart, spleen, liver, and kidneys are very commonly met with   The only instance of necrotic infarct of the liver which the author has seen was a case of this kind

The process appears to begin as an inflammatory change in the adventitia, associated with round cell infiltration and proliferation of the endothelium of the vasa vasorum   The change spreads to the media and is followed by hyaline and necrotic change in the non-striped muscle, which then gives way along with the elastic laminæ, leading to the formation of multiple small aneurysms   Thrombosis often follows with organisation of the thrombi, thus producing the infarctions

Opinion is divided as to the cause of the disease   Some ascribe it to the action of a virus of unknown nature   Others consider that the condition is a syphilitic one   Certainly in a considerable percentage of cases a history of syphilis has been obtained   There are others again who separate the syphilitic cases into a special category by themselves

B DISEASES OF VEINS

Thrombosis occurs in veins where the blood current is slowed from dilatation and varicosity   In all probability in addition there must be some inflammatory condition of the vessel wall leading to damage of the endothelium   The condition may be found in any vein where walls are inflamed   Thus the small venous radicles in the neighbourhood of any inflammatory focus tend to undergo thrombosis   When organisms invade such thrombi and soften and break them down, portions of the thrombus containing germs are apt to be carried away by the blood current and deposited in distant organs   The liver is affected when the rootlets of the portal vein are thrombosed , the lung, in the case of other venous radicles, becomes the seat of septic embolism and abscess formation (see diagram, p 66)

Thrombosis once started tends to spread Not infrequently the change begins in the pouch of a valve The thrombus grows until it blocks the lumen of the vessel Then the blood current being stopped, thrombosis occurs in the vessel up to the next large branch. Subsequently another slow thrombotic process starts, until again the vessel is blocked In this way the process initiated in a small rootlet of the femoral vein may pass up as far as the inferior vena cava.

Thrombi in veins may become organised and may lead to obliteration of the vessel Or they may be the seat of deposit of calcareous material forming so-called phleboliths. Again, sometimes the thrombus in course of organisation may be tunnelled and the circulation re-established

Two types of thrombi are distinguished according to their colour, (a) red, (b) white. Red thrombi form when the blood is suddenly brought to a standstill, white thrombi are formed when the blood is in motion

Thrombi in veins not infrequently undergo softening Two types of softening are distinguished, (a) simple softening, (b) septic, due to the action of germs

Microscopically, thrombi consist of the blood elements (red corpuscles, white cells, and blood platelets) in varying proportion, bound together by filaments of fibrin.

(a) In the case of red thrombi the predominant element is the red blood corpuscle. There are a few white cells, and between the cell elements filamentous and granular fibrin. Sometimes the red cells stain well, at other times they have lost their characteristic staining reaction and only their outlines are visible.

(b) In white thrombi leucocytes, platelets, and fibrin predominate. Organisation is frequently seen. The first stage in the process is a covering over of the thrombus with a layer of spindle shaped endothelial cells from a proliferation of those lining the vessel. Then from the subendothelial and other connective tissue layers, young connective tissue cells emigrate

into the thrombus They appear as rounded mononuclear cells to begin with , later on they become spindle shaped At the same time the endothelial cells of the vasa vasorum proliferate, forming buds of vessels which penetrate the thrombus Both these processes occur at points where the thrombus is in contact with the vessel wall. Elsewhere the endothelium covering the thrombus develops buds which penetrate the substance of the coagulum and become filled with blood from the original lumen Subsequently these various blood channels unite with one another, become enlarged, and thus the thrombus becomes tunnelled During the process of organisa tion, pigment (hæmatoidin) granules are deposited in large numbers in the cells

Dilatation and Varicosity —This is a condition which is found more especially in the superficial veins of the lower limbs, in the veins of the scrotum (varicocele), rectum (hæmorrhoids), and œsophagus

As regards *causation* there is undoubtedly a tendency to the condition in certain individuals owing to a congenital weakness in the elastic tissue of the vessel wall The condi tion is aggravated by gravity It may also be caused by obstruction to the return of the blood by the wearing of tight garters, by the presence of a tumour or hard fæcal masses pressing on the iliac veins, or by a cirrhotic liver interfer ing with the flow of blood through the portal veins, and affecting more especially the rootlets from the rectum and œsophagus

The veins which are the seat of the change are dilated and tortuous Their walls are thickened and there may be thrombosis within them Ulceration from skin, œsophagus, or rectum may lead to erosion and consequent hæmorrhage

Phlebitis, or inflammation of the wall of a vein, may be due to injury, or to an inflammatory focus in the neighbour hood of a vein, as in appendicitis, osteomyelitis, erysipelas It may also occur in syphilis and in gout The condition is

always associated with more or less thrombosis or clotting of the blood within the vessel It is one of the most important pathological conditions especially when it is due to the action of germs Veins, on account of their thin walls, are much more liable to inflammation than arteries, and on account of the slow current in the blood thrombosis occurs more readily Further, because of the increasing size of the lumen in the direction of the blood current, portions of clot are more *readily washed away* As previously stated, these thrombus fragments become strained off, in the case of the systemic veins in the lungs in the case of the portal veins in the liver If the fragments contain germs, secondary foci of infection, often abscesses, are set up Very minute fragments and individual bacteria when shed off may pass the capillary barrier and enter the arterial circulation, when a general septicæmia or pyæmia results Sometimes the thrombosis is the primary process and the germs invade later, as in puerperal septicæmia. At other times (sinus thrombosis in middle ear disease, osteomyelitis, appendicitis) the inflammatory condition sets up the thrombosis in the veins of the surrounding tissue

Results—Obliteration of the vein, washing away of portions of thrombi, and so formation of emboli, metastatic foci of infection in organs such as lung and liver, reabsorption, or tunnelling

CHAPTER VI

DISEASES OF THE BLOOD, BONE MARROW, LYMPH GLANDS, SPLEEN, AND DUCTLESS GLANDS

DISEASES OF THE BLOOD

ALTHOUGH it is unquestionably better to examine the blood during the life of the patient, it is still possible to do so after death   The ease with which this can be done depends to a great extent upon how far the blood has coagulated within vessels and heart   There is, however, in blood diseases, such as anæmias and leukæmias, a tendency for the blood to remain fluid so that films may often be readily obtained either from heart blood or vessels

Septicæmia and Pyæmia. — Micro-organisms enter the blood in many infective conditions   In fact, in most acute infective diseases the causal organism can be cultivated from the blood at some period   Even in the more chronic forms, such as tuberculosis, germs can be detected in the blood in a considerable proportion of cases   Such conditions, in which living organisms are circulating in the blood stream, are usually known as *septicæmias*   Formerly the term was somewhat restricted in its use , now it may be applied to a large number of acute infective processes

including typhoid fever and pneumonia. In the human subject the germs are almost never present in numbers *sufficient for their demonstration readily in stained blood films*. Concentration or cultural methods have to be adopted before their presence can be detected. On the other hand, the same germs may, when introduced into one of the lower animals, give rise to a condition in which immense numbers of film organisms can be demonstrated microscopically in the blood. This is notably the case with the *pneumococcus* and the anthrax bacillus.

The organisms may enter the blood, in the case of the smaller blood vessels, through an intact vessel. In other instances an abscess or similar infective focus (in tuberculosis a caseous focus) may rupture directly into the blood-stream; it may be into a vessel of considerable size, usually a vein. In a majority of instances, in the more acute infective diseases, the actual invasion of the vessel is preceded by a thrombosis within the lumen, the thrombus then becomes infected with germs, and portions of the infected clot are carried to other parts of the body, *there to set up metastatic inflammatory foci, or abscesses*. This condition of invasion of the blood-stream by organisms *plus* the formation of metastatic abscesses is usually known as *pyæmia*.

The primary focus from which the infection of the blood originates varies very much. It may be the intestine as in typhoid fever, the organism probably reaching the blood by way of the lymphatics. It may be the lung as in acute lobar pneumonia, the organisms passing directly from the alveoli into the pulmonary capillaries. In the conditions more usually characterised by the term septicæmia, it is commonly a suppurative focus in the throat, appendix, bone (in osteomyelitis), prostate, or an endocarditis of the malignant or ulcerative type.

When secondary suppurative foci develop these may be found in kidneys, liver, brain, or indeed in any part of the

body in the case of an ulcerative endocarditis, in the lungs most commonly in the case of an osteomyelitis, in the liver in the case of the appendix (portal pyæmic type of liver abscess)

Sometimes a condition may start by being merely a septicæmia   Subsequently it develops into an ulcerative endocarditis and pyæmia   Apparently organisms in the blood stream have a special tendency to become deposited on the heart valves, especially such as have already been damaged

Both in miliary tuberculosis and in septicæmia the secondary infective foci invade blood vessels in their neigh bourhood and so further infect the blood stream with germs

Anæmia

Anæmia or bloodlessness may be defined as deficiency in one or more of the blood elements   Commonly the index to the degree of anæmia is taken as the number of red cells and the percentage of hæmoglobin   In some cases the one, in others the other, shows the greater diminution   This decrease in the red elements may or may not be accompanied by deficiency of leucocytes, which is known separately as leucopenia   The amount of plasma varies in different kinds of anæmia, being excessive in the chlorotic type and varying in amount in the pernicious variety

Anæmia may be due to various causes   These may be classified as follows

1 *Defective ingestion of blood forming ingredients,* as in cases of starvation and obstruction to the entrance of food, *e g* in stricture of the œsophagus   Deficiency of such chemical substances as iron   Defective gastric secretion or achylia

2 *Any chronic drain upon the system* which it is unable to supply, as for example the persistent loss of albumen through

the kidneys in Bright's disease and repeated hæmorrhages from the uterus, bowel, or other passage.

3 Interference with the formation and renewal of the blood This is probably the commonest cause of all It may be due to many and various factors. The more important of these are

(*a*) Infections and intoxications, such as in fevers, prolonged suppurations, chronic infective disease, *e g* tuberculosis and syphilis Poisons such as lead act in a similar way Such conditions operate chiefly through their influence on the bone marrow

(*b*) Failure of the red cell forming marrow through replacement of it by some other tissue This may be, although rarely, due to the presence of metastases of malignant tumours in the bone or bone marrow Such are sometimes found in cases of carcinoma of the prostate and breast. In a case recently under the writer's notice the vertebræ and the long bones were the seat of numerous large deposits of malignant growth replacing the proper tissue and leading to a profound anæmia. The primary tumour in this case was in the prostate A similar result may be produced by a thick ening of the bone at the expense of the marrow cavity Probably for this reason the not very appropriate term of *osteosclerotic anæmia* has been given to this group of cases

Again, the red cell forming tissue may be crowded out on account of excessive activity in the white cell producing marrow This we find in the different types of leukæmia.

Again, the marrow may be replaced by a low-grade type of tissue of no use in forming red cells Such is the case sometimes in old age and prolonged toxæmias, *e g* syphilis, when myxomatous or fibrous tissue replaces the marrow Or again, fatty tissue may be found not only in the shafts where it is normal, but at the ends of the bones where it is not normal. The term *aplastic anæmia* has been given to this type of case, which is due to a complete failure of the erythroblastic tissue to react

4 Lastly, we have *increased loss or destruction of the blood* as a cause of anæmia   The blood is always undergoing destruction, but in normal cases this is balanced by regenera tion   Sometimes the destruction is in excess of the regenera tion and then anæmia supervenes   It is in most cases very difficult to state with certainty how far this process is opera tive and how far an anæmia is due to interference with regeneration, but in what is called pernicious anæmia the evidence of blood destruction by organs such as the liver, spleen, and bone marrow is so great that it is difficult to believe that it is not a prime factor in the bloodlessness , at the same time in such cases toxic substances acting on the marrow are probably often the initial cause

Again, the destruction may be due to the direct action of a parasite on the blood cells, as in malaria   Or it may be due to the influence of some (hæmolytic) poison on the blood corpuscles , this poison being sometimes a chemical substance such as potassium chlorate, sometimes an animal poison such as those obtained from snakes and spiders   Similar hæmolytic poisons are produced by bacteria (*B tetani*) and by plants (*Ricinus communis*)

Then again the anæmia may be due to actual loss of blood (a) from deficient coagulation following injuries as in hæmophilia, or (b) from escape from the vessels either in large quantities at one time or repeatedly in smaller quantities This loss may be due to some injury or disease such as cancer eroding large vessels or tuberculous disease destroying lung tissue, or it may be due to an exaggeration of a normal loss as from the uterus at the menstrual period

Anæmias are often classified into (a) Primary and (b) Secondary , the primary anæmia being due to no definite recognisable cause, the secondary anæmia being due to such a cause   The distinction is obviously not a good one, as the primary anæmias are also due to some although as yet unrecognised cause   Thus we distinguish as primary

anæmias chlorosis and pernicious anæmia and as secondary
the anæmia of Bright's disease and cancer, osteosclerotic
anæmia, and aplastic anæmia.

The post mortem appearances in the anæmias, with the
exception of the pernicious variety, are neither constant nor
characteristic. Pallor of the skin, mucous membrane, and
internal organs is the one and only feature always present.
In the severer types small hæmorrhages are found in serous
and mucous membrane   Fatty change in liver and other
parenchymatous organs, also in the endothelium of vessels,
tends to occur because of the lack of oxygen in the tissues in
any prolonged anæmia. The bone marrow, except in the
aplastic type, tends to show an erythroblastic reaction
extending from the ends into the shafts of the long bone
marrow   Excessive pigmentations of liver, spleen, etc., is
only found in the pernicious type. The various causes of
a secondary anæmia should always be looked for carefully
The possibility of secondary deposits in such bones as the
vertebræ should be examined in all malignant cases, more
especially in those of the prostate, breast, and thyroid   Any
elaborate investigation of the long bones is a difficult matter,
but slices are readily removed from the anterior surface of the
bodies of the vertebræ by means of a flexible saw.

Chlorosis is not a condition which is often fatal   There
are no constant or characteristic appearances found after
death beyond pallor and *fatty change with erythroblastic
reaction of bone marrow*   Thrombosis may occur spontane-
ously especially in such vessels as the brain, and Virchow
described *a condition of hypoplasia of the heart and aorta*

Pernicious Anæmia. — In performing a post mortem
examination in a case of this disease the following changes
will be found with a remarkable degree of constancy

The *skin* is pale, often with a lemon yellow tint due to a
slight degree of jaundice. The *subcutaneous fat* may be

considerable in amount and shows a bright yellow colour   In examining the *serous sacs* minute hæmorrhages will be found, more especially under the visceral pleura and pericardium The *lungs* are pale and show atrophic emphysema   Not infrequently small hæmorrhages are found in the substance of the lungs as well as under the pleura, and on microscopic examination fatty change may be found in the endothelial cells of the vessels   The *heart* may be dilated, and is very constantly the seat of a fatty degeneration of the muscular substance, which is best seen on the inner aspect of the left ventricle, more especially on the papillary muscle   The change is of the patchy type described as " thrush breast heart "   The *blood* within the heart cavities is often fluid and always pale

The *liver* is pale and of a yellow brown colour   It shows fatty degeneration and a marked increase of iron-containing pigment (hæmosiderin)   This can be demonstrated by pouring over the organ ferrocyanide of potassium (2 per cent) and hydrochloric acid (1 per cent), repeating the process several times if the characteristic " Prussian blue " colour does not at once appear   The pigment is present mainly round the outer part of each lobule (see frontispiece)

Microscopic Appearances —The granules are found within the liver cells mainly in the outer two-thirds of the lobule, and also in the endothelial cells of the vessels.   Necrotic areas are sometimes present in the lobules.   In the vessels nucleated red cells and endothelial cells containing red corpuscles as well as pigment granules are to be found.   Fatty degeneration is present in the central part of the lobule.

Another change of interest found microscopically in organs such as liver, spleen, and lymph glands is the presence of small foci of marrow consisting of nucleated red cells and myelocytes.   In the liver these are found in the sinusoids, in the spleen in the pulp spaces, and in the lymph glands in the sinuses

The *spleen* is of a dark brownish red colour   Hæmosiderin

may be present in sufficient amount to be demonstrated macroscopically   In any case it will be found microscopically within the endothelial cells of the pulp sinuses, which also show marked phagocytosis for red blood corpuscles

The *kidney* may show nephritis of a catarrhal or interstitial type   It is very pale in colour and often exhibits the same Prussian blue reaction as is found in liver and spleen.

The *mucous membrane of the stomach and intestine* is pale, petechial hæmorrhages are often present, and there is atrophy of the mucous membrane

The *bone marrow* in the shafts of the long bones, which is normally of a yellow colour and is composed of fat, is trans formed into a bright red marrow with a gelatinous appearance and consistence   There tends to be an absorption of the bone to make room for the marrow

Microscopically, there is a marked erythroblastic reaction, the red cells showing evidence of active proliferation.   Many of them are of the large nucleated type known as megaloblasts. There is also evidence of phagocytic activity on the part of large endothelial cells, many of which contain red blood corpuscles   Myelocytes and lymphocytes are present in relatively insignificant numbers owing to the preoccupation of the marrow with red cell formation.

Occasionally in the *spinal cord* degenerative changes, with consequent sclerosis, are found in the posterior and postero-lateral columns

The chief *blood changes* of pernicious anæmia may be briefly recapitulated   There is marked diminution in the number of red blood corpuscles (average count 1⅓ millions), with a less marked diminution in hæmoglobin (average 40 per cent), so that the colour index (the ratio of the percentage of hæmoglobin to the percentage number of corpuscles, *e g* as above, $\frac{40}{30}$) is greater than unity   On the examination of a film of blood the main change is found to be variation in size of the blood corpuscles (macrocytes and microcytes being

present), with marked variation in shape (poikilocytosis)
Nucleated red corpuscles are usually to be found, and of these
the large variety (megaloblast) predominates over the normo-
blast   In addition, basophil granules are often found scattered
through the corpuscles (punctate basophilia or granular
degeneration), and not infrequently the red cell takes on both
acid and basic dye, assuming thus a bluish colour (poly
chromatophilia)   The leucocytes are commonly reduced in
number, with a slight relative increase of the lymphocytes
The blood plates are also fewer in number

In *secondary anæmias* the appearances found post mortem
are, of course, many and various, depending upon the nature
of the primary cause

Hæmochromatosis — Although not associated with a
severe degree of anæmia, this is a condition in which, as in
pernicious anæmia, hæmosiderin is deposited in internal
organs such as liver and pancreas in very large quantities
This deposition is accompanied by cirrhosis, resulting, when
the pancreas is affected, in so-called bronzed diabetes   For
long the cause of the condition was unknown, but the recent
work of Mallory appears to prove that the disease is a chronic
form of copper poisoning

Splenic Anæmia — This term is commonly used to
characterise cases of severe, unexplained anæmia, in which
splenic enlargement is a prominent feature   Undoubtedly
a number of different conditions have been included   An
adult and an infantile type are described

Under the adult form the condition known as Banti's
disease may be classified   This is characterised by an en
largement of the spleen with cirrhosis of the liver and
atheroma of the splenic and portal vessels   Microscopically,
the spleen shows a diffuse fibrosis both of the Malpighian
bodies and of the reticulum   The Gaucher type of splenic
enlargement also comes under this heading   In it the spleen
is enormously enlarged and the parenchyma is transformed

into spaces resembling the alveoli of a gland These spaces are lined by peculiar, large mononuclear cells The liver is also enlarged and contains groups of these cells Similar cells are also present in the bone marrow

The infantile type of splenic anæmia has no constant features The enlarged spleen shows microscopically a general fibrosis

The blood pictures in splenic anæmia are not constant or characteristic The general type is that of a secondary anæmia with a relatively excessive diminution in the per centage of hæmoglobin, hence a low colour index. As a rule the leucocytes are diminished

Leukæmia (Leucocythemia)

Two main types of this condition are recognised —

(1) *Myelocythemia, myelæmia, spleno-medullary leukæmia.*
(2) *Lymphocythemia, lymphæmia, lymphatic leukæmia.*

(1) *Myelocythemia.*—This is a condition in which there is an enormous proliferation of leucocytes and leucocyte forming cells, mainly of the granular variety, chiefly in the bone marrow The result is that fully developed leucocytes and immature forms (myelocytes) overflow into the circulation in large numbers The disease is probably a tumour formation related to the sarcomata.

The *blood* is often paler than normal Large greenish-yellow or white clots may be found in the heart and vessels. Films show an enormous preponderance of white blood corpuscles Instead of the normal proportion of 1 white to 500 reds, there may be 1 to 10, or even 1 to 1 The prevailing types of leucocyte present are the polymorpho-nuclear and the neutrophil myelocyte These latter are very large cells, not infrequently 20 μ in diameter, with large, pale nuclei and neutrophil granules in their protoplasm. In addition, there is a marked increase in the number of eosinophils, and eosinophil myelocytes are also present in

large numbers. Mast cells (cells with basophil granules) are present, often in great numbers   There are considerable numbers of lymphocytes and other hyaline cells, but these are relatively greatly diminished   The red cells are reduced in number and nucleated red cells of the normoblast type are usually present

The *organs generally* tend to be enlarged and have a pale appearance

The *spleen* is usually greatly enlarged (Fig 33)   It may weigh as much as 18 lbs   The enlargement is uniform, and the shape with the notches is preserved   The organ may reach as far down as the pubis   In consistence the organ is firm   The surface often shows chronic perisplenitis   Infarcts are very commonly present   On section, the cut surface has a uniformly pale pink, flesh like appearance   The Malpighian bodies are invisible.

Microscopic Appearances —The sinuses of the pulp are filled with leucocytes of the different types   In addition, there are numerous swollen endothelial cells, in some of which red blood corpuscles can be seen   There is increase of fibrous tissue and pigment, the fibrous tissue spreading from around trabeculæ and vessels.   Malpighian bodies are inconspicuous

The *bone marrow* throughout the body has a pale pink colour. The marrow of the shafts of the long bones, instead of being fatty, has a similar pale pink appearance

Microscopically, granular cells of all kinds are found present *in greatly increased numbers.   There is evidence of great rapidity of division (mitotic figures) among all types of myelocytes   Red cells are relatively few in number

The *liver* (p 241) and *kidneys* (p 289) are enlarged and pale, and show microscopically more or less infiltration with leucocytic cells   The lymphatic glands may or may not be enlarged

(2) Lymphocythemia.—In this type of the disease there

is a proliferation of the leucocytes of the non-granular or hyaline type These overflow into the blood and infiltrate the organs The condition, like the previous, is probably neoplastic in nature

The *blood* is pale, and films show usually a marked increase of white corpuscles This is seldom so marked as in the previous type of the disease Occasionally there is no increase. The prevailing type of leucocyte is the lymphocyte, large or small These form from 90 per cent to 99 per cent of the white corpuscles Granular cells are few and far between The red blood cells are reduced in numbers, and nucleated corpuscles are usually present

The appearance of the *bone marrow* is similar to that found in myelocythemia But on microscopic examination lymphocytes instead of the granular cells predominate

The *lymphatic glands* are very commonly enlarged, sometimes attaining the size of a hen's egg

Microscopically, they are found infiltrated with immense numbers of lymphocytes.

The *spleen* is usually enlarged, although it does not attain the size of the organ in well marked cases of myelocythemia.

Liver and *kidneys* tend also to be enlarged, the latter are usually very pale and show numerous hæmorrhages scattered through them

Chloroma.—This is a rare condition, found chiefly in male infants It is characterised by the presence of greenish coloured tumours, mainly in connection with the periosteum of bones, *e g* in the orbit, causing marked protrusion of the eyeballs and on the vertebræ These, on microscopic examination, show the character of round-cell sarcomata Deposits with similar characters may be found in the lymphatic glands and bone marrow, and in the liver and kidneys The coloration of the masses is due to a pigment which occurs in a granular form, and is probably of a fatty nature.

Blood films show appearances similar to those seen in lymphocythæmia A myeloid type also occurs

Polycythæmia, or increase in the number of red corpuscles per unit volume of blood, is due to various causes It is not an infrequent occurrence brought about through loss of fluid from the plasma and consequent concentration of blood as in diarrhœa, or through some demand for increase in the number of oxygen carriers, as, for example, in persons living at a high altitude Another type of the condition is met with in chronic lung and heart disease when there is backward pressure and cyanosis In such cases the increase is probably local, due to concentration of the red cells in the peripheral capillaries

There is, however, a disease in which a marked and persistent increase in the number of blood cells and in the amount of circulating blood is found This is known as *polycythæmia rubra* or *splenomegalic polycythæmia* The blood is dark coloured The number of red cells may reach 14,000,000 The hæmoglobin is also increased, but not so greatly as the red cells There is a slight increase in the leucocytes The volume of blood is raised and may be two and a half times the normal The heart is hypertrophied and the vessels thickened Spontaneous severe hæmorrhages tend to occur from the stomach or other mucous membrane, but give only temporary relief The spleen is enlarged, and the red marrow extends from the ends into the shafts of the long bone The exact cause of the condition is unknown, but it would seem that there is an uncontrolled increased production of red corpuscles on the part of the marrow due to hypertrophy

CLASSIFICATION OF DISEASES AND REACTION OF THE BLOOD AND BLOOD-FORMING ORGANS

A. Reactions and Hyperplasias of Hyaline Cells
  (a) With leakage into the circulating blood

1 With overgrowth of lymphoid tissue and
lymphoid infiltration of organs
Chronic and Acute Lymphatic Leukæmia

2 With tumours of an invading type
Lymphoid Chloroma

3 Lymphocytosis often with focal infiltration in
infections such as tuberculosis, syphilis, and
whooping-cough, and in cachexias such as
pernicious anæmia.

4 Large hyaline cell leucocytosis as in malaria

(b) Without leakage into the circulating blood

5 With tumours involving bone marrow
Lymphoid Myeloma

6 With regional invading tumour like growth ·
Lymphosarcoma

7 With general lymphoid hyperplasia and sub-
acute infections
Status Lymphaticus

B Reactions and Hyperplasias of Granular Cells.

(a) With leakage into the circulating blood

8 With infiltration of the organs
Myeloid Leukæmia

9 With invading tumours of the myeloid tissue
Myeloid Chloroma

10 Polymorphonuclear leucocytosis, often with
focal infiltration of tissue as in a majority of
acute infections.

11 Eosinophil leucocytosis as in many animal
parasitic diseases etc., sometimes with focal
infiltration of tissue as in asthma.

(b) Without leakage into the blood

12 With tumours of myeloid tissue
Myeloid Myeloma

C. Tumour like swelling of Lymph Glands with nodules in Spleen associated with a gradual replacement of lymphadenoid tissue by overgrowth of stroma and endothelial elements, probably infective
    13 *Hodgkin's disease* or *Lymphadenoma*

D Reactions and Hyperplasias of Red Cells
    (a) With leakage into the circulating blood
        14 Polycythæmia
    (b) Without leakage into the blood
        15 Red cell myeloma

HÆMORRHAGIC DISEASES

Hæmorrhage, or escape of blood from the vessels or heart, is a feature of a great many diseases It is due either to a damage of the vessel or heart wall from disease or injury, or to unusual blood pressure within Not infrequently both factors are operative Sometimes it is due not so much to these factors as to deficient coagulability of the blood That is to say, some slight imperceptible injury starts the hæmorrhage and nature fails to close the breach Hæmorrhages may be localised and solitary or widespread and numerous, when very minute the term petechial hæmorrhage is applied Most of the localised or focal hæmorrhages are dealt with under the heading of the various organs—lung, brain, etc. Conditions in which hæmorrhage is a feature—where it occurs as a widespread manifestation—may be classified together as Hæmorrhagic diseases The morbid anatomist meets with these widespread hæmorrhages frequently They are to be sought for in particular situations, notably skin; serous membranes such as pleura, peritoneum, pericardium, mucous membranes such as intestine, bladder, and, less frequently, in solid organs such as spleen and brain The conditions in which they are found may be classified as follows

    1 Infective diseases such as pyæmia and ulcerative endo-

carditis, and specific infections such as cerebro spinal meninggitis and epidemic encephalitis In such cases the factor
which weakens the vessel wall is the toxin of the bacteria,
sometimes it is an infective embolus blocking a vessel

2 Toxic conditions such as jaundice (where the damage
to the vessel wall is due to the action of the reabsorbed bile
salts), snake bites, quinine poisoning

3 Cachectic conditions such as scurvy and the severe
anæmias, notably pernicious anæmia. The factor here is
deficient nourishment of the vascular endothelium, which
gives way in consequence

4 Cases where there is a sudden rise in blood pressure,
such as death from suffocation

Purpura is a term which is seldom used by pathologists
In its clinical significance it covers cases where visible hæmor
rhage into the tissues is a main feature The following
types may be distinguished

1 Purpura hæmorrhagica a fault of the blood in which
the blood platelets are greatly diminished In fatal cases
hæmorrhages are found into various organs of the body,
especially into the central nervous system

2 Symptomatic purpura, a disease in which there is usually
a normal number of blood platelets The pathology of the
condition is not clear, but it is supposed that some change
in the small blood vessels causing increased permeability is
the explanation of the hæmorrhages It is possible that an
anaphylactic element is present in such cases It may be
that in some infection e g by streptococci plays a part The
incidence of the hæmorrhages is variable To those cases
which are combined with colic, and, when diffuse hæmorrhage
into the bowel is found, the term Henoch's purpura has been
given Such cases are often accompanied by nephritis.
Rheumatic or arthritic purpura has been used to designate
those associated with multiple arthritis

Scurvy is a disease caused by improper diet—an excess

of meat (especially salted meat), and an absence of fresh
vegetables   The particular element wanting in this diet is
C vitamine   It is characterised by a swollen, spongy con
dition of the gums which readily bleed, and by hæmorrhages
under the skin and into the muscles and joints   The disease
is believed to be an acid intoxication with diminished alkali
nity of the blood   The coagulation of the blood is slow and
incomplete, the other characters being those of a secondary
anæmia   Post mortem, beyond the appearances of cachexia
and the hæmorrhages into the skin and muscles, there is little
to note

Infantile Scurvy (Barlow's disease) is a condition
which is occasionally seen in infants, not infrequently those
of the well to-do   It is also due to an absence of C vitamines
from feeding with boiled or pasteurised milk or proprietary
foods such as dried milks   Marked cases are characterised
by fusiform swellings of the shafts of the long bones, particu
larly the tibia and femur   These swellings are due to hæmor-
rhage beneath the periosteum   The periosteum is always
highly vascular   Occasionally the condition is seen also in the
upper extremities   Fracture of the shafts of the long bones
is occasionally met with   Microscopically, the bones are
abnormally vascular and there is absorption of the bony
trabeculæ   There is also defective bone formation, and the
marrow may be replaced by myxomatous tissue

Hæmophilia is a hereditary disease occurring almost
exclusively in the males but transmitted exclusively by the
females of a family   It is characterised by a tendency to
persistent bleeding either spontaneous, or from slight wounds,
such as the socket of a tooth   Although sometimes fatal,
nothing abnormal is to be found post mortem   It is stated
that there is an unusual thinness of the blood vessels with
fatty change in the intima   This, however, is not always
present, and may be merely the result of secondary anæmia
Without doubt the uncontrolled bleedings are to be ascribed

8

to defective coagulability in the blood, in all probability to a deficiency in the amount of prothrombin. Sometimes the large joints, especially the knee, show in this condition appearances not unlike those found in rheumatoid arthritis There is thickening and fibrillation of the synovial membrane with the formation of fringes which are coloured yellow red from old hæmorrhages At the same time there is also destruction of the articular cartilages

DISEASES OF THE BONE MARROW

At birth the bones of the body, both long and flat, are filled with active, blood producing marrow, and contain no fat. Certain bones, notably the sternum, innominate bones, vertebræ, and ribs, retain this character throughout life, but in the case of the long bones a gradual process of transformation of the red marrow into fat occurs This process begins to be visible about the age of puberty Commencing in the shaft it gradually extends towards the ends of the bones Islands of active marrow remain even in the shafts, especially in relation to the bone itself, but the main reservoirs of hæmopoietic tissue in the long bones are to be found in the ends From all these reservoirs, should a demand for increased activity arise, the blood forming tissue is able to extend, and it may be again to occupy the marrow cavity of the shaft

At the autopsy the bone marrow should be examined in such readily accessible positions as the ribs by pressing the marrow out by means of bone forceps Films of the marrow can then be made and, after fixation (best in corrosive sublimate), stained by such methods as Wright s, Leishman s, or Jenner's An examination of this kind will give information as to the cell process taking place in the marrow generally, but in order to obtain some notion of the extent of the active marrow area, i.e. whether or no regenerative and hypertrophic changes have occurred, the marrow of the shaft of one of the long bones should be investigated Of course more

complete information is obtained by examining the whole length of the bone in section, but this is seldom permissible, and the pathologist has to be content with an examination of a small segment of a shaft of, *e g ,* the femur   This examina tion may readily be carried out by making a small incision on the outer aspect of the thigh, inserting a narrow saw and removing two or three inches of bone   In this situation the marrow may be scooped out in mass by means of a needle or sharp narrow knife, fixed like any other organ or tissue, and cut in paraffin or celloidin   Films may at the same time be made should it be considered necessary

Another situation in which an investigation of marrow is readily carried out is the bodies of the vertebræ   Slices of bone can be removed from the spinal column, especially in the projecting lumbar region, by the use of a flat saw with the back removed

The marrow should be examined more especially in all cases of anæmia, in cases where there is enlargement of spleen or lymph glands, in infective conditions such as pneumonia or endocarditis, and in cases of malignant tumour, particularly of breast, prostate, and thyroid gland

The functions of the marrow are (*a*) the formation of red blood corpuscles, (*b*) the formation of all types of white blood cells and of blood platelets, (*c*) the destruction of effete red cells, (*d*) the formation of an internal lining to the bone by which new bone can be produced or removed, and (*e*) the storage of fat   The two main functions are of course the formation of red and white corpuscles, and the chief patho logical changes are found in relation to diseases of the blood involving these cell elements   The centres for forming the two types of corpuscles are mixed up with one another so that when any unusual demand is made upon one or other function the increased activity on the part of one type of tissue results in interference with the function of the other type   But the marrow possesses in remarkable degree the capacity to

hypertrophy in response to an increased demand for its cell elements, red or white This hypertrophy takes place from the active cell forming marrow at the expense of the fatty marrow situated chiefly in the shafts of the long bones When all available space is occupied by active marrow the area can be still further increased by absorption of bone This sometimes takes place in severe cases of pernicious anæmia Moreover, under similar circumstances *metastatic deposits* of active marrow may be found in organs such as liver, spleen, and lymph glands In fact there is probably no organ of the body so capable of rapid and extensive response to a stimulus

Inasmuch as there are, roughly speaking, two types of cells produced by the marrow, so two types of regenerative hypertrophy are to be distinguished (1) *erythroblastic marrow*, in which the response is mainly on the part of the red cell forming tissue, and (2) *leucoblastic marrow*, in which the response is chiefly from the leucocyte-forming cells.

Erythroblastic Marrow is found in cases where there has been a call upon the red cell forming function, such as anæmias of all kinds both primary and secondary with the exception of aplastic anæmia It is also found in the disease polycythæmia rubra The marrow is redder than normal and extends from the ends into the shafts of the long bones, replacing the fatty marrow In extreme cases, as in pernicious anæmia, the appearance has been compared with that of red currant jelly In this disease the bony trabeculæ may be absorbed to a certain extent, leaving the interior of the shaft smooth It is in this disease also that metastatic deposits of red marrow sometimes occur in organs such as spleen, liver, and lymph gland These deposits are, however, only visible on microscopic examination.

Microscopically, this type of marrow is characterised by a relative increase in the number of red cells chiefly of the nucleated variety, many of these showing evidence of active

division   More especially in pernicious anæmia the nucleated red corpuscles are of a specially large type (megaloblast). Another function of the marrow is often strikingly in evidence in pernicious anæmia, and that is the blood-destroying function. Thus phagocytosis of endothelial cells for red corpuscles and hæmatoidin and hæmosiderin pigmentation is often very marked

Leucoblastic Marrow is found in all infective conditions associated with the presence of excess of leucocytes in the circulating blood, *e g* pneumonia, infective endocarditis   It is also found in the two types of leukæmia   Two varieties of the condition are distinguished according to the type of cell chiefly involved in the reaction, whether granular cell (*myelocytic*) or small hyaline cell (*lymphocytic*)   In virtue of the greater dilution of the red cell elements such a marrow has a paler appearance than the normal   The more marked the reaction the greater is the replacement of fatty marrow by this pale red marrow   In the leukæmias the replacement is often complete, extending throughout the shaft, the marrow has a mottled appearance due to paler patches alternating with red erythroblastic tissue

Microscopically, such marrow shows increased proliferative activity on the part of the white cell forming tissue.   Myelocytes of all kinds are to be found in process of multiplication.   In infective conditions and in myelocythæmia the granular cells, both fine and course, predominate   In conditions such as status lymphaticus, rickets and lymphocythæmia the lymphocytes predominate.   In both types the red cell forming function is relatively quiescent, so that nucleated and fully formed red corpuscles are few, and as a result there is a relative diminution of the red elements in the circulating blood.

Aplasia—Although in a majority of instances the bone marrow responds to the formative stimulus, in some cases it fails to do so or does so only imperfectly   This failure, complete or incomplete, may be due to a congenital defect, to some toxin inhibiting its activities, or to some tissue, fibrous or neoplastic, occupying the interior of the bones   The result in all cases is the same—a failure adequately to

replace the blood cells which are constantly being destroyed in the wear and tear of life, with consequent anæmia. Such an anæmia is known as aplastic (see p 100)

Degenerations.—In old age and under the influence of chronically acting toxins the active marrow tissue is apt to be replaced by fibrous or myxomatous tissue. The poison of syphilis is peculiarly apt to act in this way with resulting severe anæmia. Areas of focal necrosis occur in the bone marrow in cases of typhoid fever just as they do in such organs as spleen and liver

Inflammations.—Organisms of all kinds have a special tendency to lodge in bone marrow. This is no doubt due to the vascularity of the tissue. As these inflammations early affect the bony tissue, they are properly considered under the heading of osteomyelitis (see p 3^8)

Tumours.—Tumours occurring in the interior of bones may be primary or secondary. The primary ones form a group to which the term *myeloma* is given. They are all of the nature of sarcomas and bear a relation to the blood diseases known collectively as the leukæmias. They must be distinguished from the myeloid or giant cell sarcoma (see p 363)

Such tumours are commonly multiple and occur in many bones at the same time. They appear as grey or pink areas in the marrow, absorbing the bone and thus leading to spontaneous fracture. Metastases in tissues other than bone marrow are rare. A peculiar form of albumose (Bence-Jones) appears in the urine in some cases of multiple myeloma.

Microscopically, four forms of this myeloma are distinguished. One, which arises from the primitive nucleated red cell and is composed of small round cells, is extremely rare and is known as erythrocytoma. Another type is composed of lymphocytes and of plasma cells. Still another is that in which the cells are large and may be granular arises from the myelocytes and is known as myelocytoma. (See table, p. 109).

Secondary growths in marrow are usually carcinomas in

which the primary tumours are found in prostate, breast, or thyroid   They lead to the formation of more or less fibrous tissue which with the tumour tissue replaces the marrow proper, leading to a form of secondary anæmia (osteosclerotic)   Such secondary deposits commonly arrive by way of the blood stream as the marrow possesses no lymphatics, but direct invasion of the vertebræ by continuity of tissues from infiltrated retro-peritoneal glands probably occurs

DISEASES OF LYMPH GLANDS

Atrophy of the lymphadenoid tissue occurs in old age. The fibrous stroma of the nodes increases as the expense of the lymphatic tissue   Thus the glands become smaller, firmer, and, unless pigmented, paler in appearance

Amyloid degeneration of the arterioles of the lymph *follicles and of the reticulum is sometimes found in the* conditions in which waxy disease tends to occur   It is found occasionally apart from the generalised disease as local amyloid   Such glands are pale, somewhat translucent, enlarged, and firm

Hyaline degeneration of the reticulum of lymph glands is a common occurrence in tuberculosis and other infect ive diseases   The connective-tissue fibres become swollen, homogeneous, and stain uniformly with acid dyes such as eosin or fuchsin

Calcification of lymph glands is a common occurrence in old, healed tuberculosis, the calcareous maternal being deposited in the necrotic caseous foci   Sometimes com paratively large aggregations of mineral salts are found, the size of a pea   When jugged these may work their way through into a channel such as a bronchus, causing, it may be, severe hæmorrhage in so doing

Pigmentation.—The pigment found in lymph glands may be derived from internal sources such as extravasated blood, or from external sources such as carbon, stone, and the colour

ing matter used in tattooing   Carbon pigmentation more or
less pronounced is practically a constant finding in bronchial
and mediastinal glands

The particles of pigment become deposited first in the
sinuses   They set up irritation associated with proliferation
of endothelial and connective tissue cells   Such glands are
enlarged, firm, sometimes hard and gritty, grey, black, yellow,
or parti-coloured, according to the pigment present   The
microscopic appearances are those met with in chronic
lymphadenitis

Œdema of lymph glands is common in cases of passive
congestion, dropsy, and inflammation of an acute type   Such
glands are enlarged, pale, or pink according to the amount of
congestion, translucent and moderately firm, but exuding
fluid on pressure   Microscopically, the sinuses are distended,
and the various tissue elements more or less widely separated
from one another

Acute Lymphadenitis—This is to be seen in the glands
through which drain the lymphatics of any area that happens
to be the seat of acute inflammatory changes, the axillary or
inguinal glands in cases of poisoned wounds and bubonic
plague, the mesenteric glands in typhoid fever   The gland
is enlarged, often congested, fairly firm in consistence, some-
times with areas of hæmorrhage or necrosis, or even softening
and suppuration

Microscopically, the blood vessels are congested, there is
infiltration with inflammatory exudate, which is sometimes
fibrinous, proliferation and throwing-off of the endothelial
cells lining the sinuses   areas of hæmorrhage and necrosis,
with possibly accumulations of polymorphonuclear leucocytes,
and in some cases (plague, typhoid) the causal organism in
considerable numbers

Chronic Lymphadenitis.—This is to be observed in
connection with areas wl ere there is chronic inflammation of
any kind, also as the result of the presence of pigment   The

gland is enlarged and firm, the capsule thickened and often adherent to neighbouring glands   On section, the structure is pale unless pigment is present

Microscopically, there is fibrous overgrowth in the capsule and trabeculæ   There is also catarrh and proliferation of the endothelial cells of the sinuses and proliferation of the lymphoid cells

Tuberculous Lymphadenitis —This is a very common condition, and should be carefully looked for in all cases. The glands which are the seat of the change are enlarged In the early stage they are discrete, and, on section, grey and translucent, with, as a rule, areas of opaque white or yellow caseation. In the later stages they tend to be adherent to one another and to surrounding structures, their capsules are thickened, and, on section, the gland substance shows caseous (Fig 37) and sometimes also calcareous change   Evidence of tuberculosis should be looked for more especially in the cervical, mediastinal, bronchial, mesenteric, and retro-peritoneal groups of glands

Microscopically, in addition to the changes found in a non specific chronic inflammation (see above), there are typical tubercle follicles and areas of caseation   Tubercle bacilli are commonly few and scattered. When they occur they are usually to be found in a zone at the margin of the caseous area.   Occasionally they may be found in considerable numbers, and sometimes in the giant and epithelioid cells   Hyaline and very occasionally amyloid change may be found in the stroma and walls of vessels

Syphilitic Lymphadenitis —In the primary stage of the disease the lymph nodes draining the area of infection show the appearance of an acute inflammation, sometimes with suppurative softening

In the secondary stage many different groups of lymph glands, cervical, epitrochlear, axillary, inguinal, tend to be enlarged and firm

Microscopic sections show proliferation of endothelial cells

in the disease and fibrous thickening of capsule and trabeculæ. The glands may remain in this condition for a long period, or they may undergo resolution

In the tertiary stage lymph glands may become the seat of chronic inflammatory processes and occasionally of gummata, which show the usual features of a caseous centre surrounded by a fibrous capsule.

Lymphadenoma or Hodgkin's Disease (also known as Pseudoleukæmia) —This is a condition which, on the one hand, resembles malignant growths, and, on the other hand, the chronic inflammatory conditions, such as tuberculosis Certain cases, with all the characteristic appearances of lymphadenoma, have been proved to be tuberculous by inoculating animals with portions of glands Other cases resemble very closely the appearance in lymphosarcoma.

The changes in the glands consist of an enlargement, usually greater than that found in tuberculosis, of a group or of several groups, such as the cervical, axillary, mediastinal, abdominal, inguinal The cervical group is the one most frequently first affected (Fig 38) The glands while enlarging tend to remain discrete (cf tuberculosis) They vary in size from a pea up to a hen's egg They are usually firm On section, they are grey and somewhat translucent with obvious bands of shining connective tissue, and possibly with yellow areas of necrosis These areas of necrosis differ from the caseous areas found in tuberculosis in being small and less opaque

Microscopically, in the earliest stage there is a hyperplasia of the lymphocyte cell elements, later there is a multiplication of the endothelial elements at the expense of the lymphoid cells, which may be relatively few and far between. Many of these endothelial cells have more than one nucleus, but when there are several nuclei these are in a group, not peripherally arranged as in the typical giant cell of tuberculosis. The tissue not infrequently shows infiltration with eosinophil leucocytes. There is always a greater or less amount of connective tissue fibres, both in connection with the capsule and

in the substance of the gland   The fibrous transformation is
found most marked in the more advanced cases   Areas of
necrosis may be present   Hyaline swelling of the connective
tissue fibres may be present.   Observers such as Fraenkel and
Much claim to have demonstrated a granular form of the
tubercle bacillus   More recently a diphtheroid organism has
been isolated by Negri   Bunting and Yates by injecting this
organism into monkeys have produced lesions similar to those
found in Hodgkin s disease   But similar bacilli have been
found in other widely different diseases.   There can be little
doubt that the disease is due to some organism, but it is fairly
generally admitted that the germ has yet to be discovered

Similar changes are to be found in certain of the internal
organs, more particularly the spleen (see p 129), less frequently
the liver (p 241) and lungs

Hypertrophy —Under this heading may be considered
the somewhat indefinite condition known as *Status Lymphati-
cus*   Found chiefly in young children, the disease, if such it
may be called, is characterised by a general pallor of the skin
from anæmia, while at the same time the child is well
nourished, often fat.   In older people the sexual organs
show imperfect development, and the suprarenals are small
The lymphoid tissue of the body generally is increased—the
tonsils, lymph glands, spleen, and lymphatic tissue of the
intestine are all enlarged   The thymus gland either does
not show its customary atrophy after the age of twenty, or it
may actually be increased in size   In some cases no more
than this lymphoid hyperplasia is found after death   In
many instances this is complicated by an infection such as
a broncho pneumonia   But there would appear to be no
doubt that those with this diathesis easily and often suddenly
succumb to conditions not usually fatal in more robust
individuals   Some regard the condition as one of subacute
infection, others see in it a congenital fault affecting the
lymphoid tissue   A certain proportion of the fatal cases in
children are due to cerebral hæmorrhage apparently connected

with imperfect development of the walls of the blood vessels of the brain.

Tumours of the Lymph Glands — *Lymphomata* or tumours of lymphatic tissue, in which the various elements retain their normal proportions, may be found in the mediastinum, tonsils, etc.

Lymphosarcomata or malignant growths arising in connection with, and having the structure of lymphatic tissue, are found not infrequently in the mediastinum invading the roots of the lungs, or in the abdomen. They tend to produce metastases in the other organs. They form a very malignant type of tumour, and usually show microscopically the appearance of a round-cell sarcoma

Secondary growths in glands are to be looked for in all cases of malignant disease, more especially in carcinoma

DISEASES OF THE SPLEEN

Rupture of the spleen is common in severe injuries of the abdomen. The bleeding from the torn organ is usually severe, and may be fatal. A spleen enlarged from disease, as in malaria, is apt to rupture from a comparatively slight injury

Atrophy — This is practically a normal process in extreme old age. The organ becomes smaller, its capsule thickened and shrivelled. On section, there is found an increase of fibrous tissue, the pulp is of a dull, reddish brown colour and bloodless. The organ is somewhat tough in consistence

Waxy or Amyloid Degeneration — This change is to be looked for in all cases of prolonged suppuration, advanced tuberculosis, and visceral syphilis. There are two types of the condition

(1) **Sago** — The organ is usually somewhat increased in size, but the increase may not be marked. In consistence it is usually firm, and, when cut into, the edges remain sharp. The cut surface shows numbers of round, translucent areas, uniform in size, but varying in size in different cases, and

regular in distribution (Fig 34) These give the typical mahogany brown reaction with iodine solution

Microscopically, the waxy change is found to be chiefly in the Malpighian bodies The central artery may or may not be affected Round the artery there is often an area comparatively free from the change The elements affected are (1) the connective tissue of the capillaries, which run from the central artery to open into the pulp, and (2) the reticulum of the lymphoid tissue. The lymphocytes themselves are pressed upon and disappear In addition (3) the inter muscular connective tissue of the middle coat of the arterioles running through the pulp will probably show the change

(2) *Diffuse*—In this variety the organ is usually distinctly enlarged It is firm, shows a sharp margin on cutting, and its cut surface has a translucent appearance and is of a pinkish red colour With iodine a diffuse mahogany brown reaction is given This type is the one most usually found in syphilitic cases

Microscopically, the change may be found, as in the previous variety, in the Malpighian bodies, but often it is restricted to the walls (periendothelial connective tissue) of the venous sinuses Frequently the sinuses are particularly well seen, owing to the organ being the seat of chronic venous congestion The arterioles of the pulp, and sometimes those of the Malpighian bodies, may show the change

Hyaline Degeneration of the arterioles of the spleen is found in certain infective fevers, such as diphtheria and scarlatina The condition gives rise of itself to no obvious alteration

Microscopically, the change is found chiefly in the intima of the arterioles, which show a homogeneous swelling, partially obliterating the lumen of the vessels.

Pigmentation.—The spleen is specially liable to *post mortem* pigmentation owing to its position close to the stomach and large bowel The organ shows a greenish black colour, which penetrates for a variable distance into its substance It is due to the action of the sulphuretted hydrogen escaping from the hollow viscera and acting upon the free iron in the organ, producing black sulphide of iron

In severe anæmias, in malaria, and in toxic conditions, there is *increase of iron containing pigment* in the organ. Thus, more particularly in the case of anæmias, may be in such quantity as to be demonstrable to the naked eye The Prussian blue reaction with dilute hydrochloric acid and potassium ferrocyanide is usually not well seen in the case of the spleen, owing to the large quantity of blood in the pulp

CIRCULATORY DISTURBANCES

Hæmorrhage —In addition to large hæmorrhages the result of injury small petechial hæmorrhages are found These are a common accompaniment of the toxic spleen of pneumonia and other infective diseases

Acute Congestion or Active Hyperæmia.—This is constantly seen in acute toxic conditions, such as pneumonia, septicæmia, acute fevers, etc. The spleen is enlarged, soft as a rule (although in typhoid fever it is often fairly firm), and pale in colour On section, the pulp is found to be very soft, often capable of being washed away in a stream of water The colour is a creamy pink The Malpighian bodies are sometimes prominent, more especially in children There are not infrequently hæmorrhages

Microscopically, the sinuses are found to be distended with blood, which shows a larger proportion of white cells than usual. There is swelling of the endothelial cells lining the sinuses, and these can often be seen to contain red blood corpuscles. In typhoid fever, areas of focal necrosis are always found, and often distinct masses of bacilli. In other conditions, organisms may be demonstrable, and even the commencement of abscess formation may be found. True abscess formation in the spleen is rare

Chronic Venous Congestion or Passive Hyperæmia.— This condition is found in (1) chronic valvular disease of the heart, (2) chronic pulmonary disease, (3) cirrhosis of the liver

The spleen is uniformly enlarged, retaining its normal shape and notches   There may be opaque areas of chronic perisplenitis   Not infrequently depressed yellow areas (pale infarcts) or dimples or puckerings indicating absorbed infarcts are visible on the surface (Fig 32)   The remainder of the organ is of a dark purple colour   In consistence it is firm   The cut surface is dark purple, with white specks and lines indicating trabeculæ, which may be more prominent than usual   Malpighian bodies are not easily seen

Microscopically, there may be some increase of the periendothelial connective tissue in the walls of the sinuses   The sinuses themselves are distended with blood   Their endothelial cells are swollen and show increased phagocytosis of red blood corpuscles   Pigment derived from these latter may be seen in the cells   Under the microscope it is exceedingly difficult to distinguish chronic from acute congestion

Infarction. — This may be due to (1)   embolism, (2) *thrombosis* occurring in a diseased artery or vein

The infarcted areas may be red or pale, and in the early stages are raised above the surface (Fig 31)   Later on they become depressed, and eventually form a pucker on the surface and cicatrix in the substance   The larger infarcts may extend right across the surface of the organ   On section, the smaller ones are, as a rule, wedge-shape, and situated superficially   The blocked vessel may be visible at the apex of the wedge, the base being formed by the surface of the organ   In the case of the older infarcts a zone of fibrous tissue forms round the margin   Within this there is frequently a zone of yellow (hæmatoidin) pigment   Rarely the infarcted areas may undergo softening   This softening may be simple or septic

Microscopic Appearances — In the earliest stage (red infarct) all that is to be noted is overfilling of the sinuses with blood and the presence of fibrin filaments between the blood cells.   Later (pale infarct) the nuclei of the splenic cells are

found to have lost their characteristic staining reaction   The outline of the sinuses and individual cells may still be seen. Still later, all evidence of structure disappears. Round the infarcted area there develops a zone of granulation tissue, consisting of young blood vessels, leucocytes, and fibroblasts in various stages of development   Within this zone, bunches of yellow acicular crystals of hæmatoidin are frequently to be observed.

INFLAMMATIONS

Acute Perisplenitis is seen in all cases of acute general peritonitis

Chronic Perisplenitis is very frequently seen as pearly white areas of thickening in the capsule of the organ   The thickening may be considerable and very hard, even like cartilages   It is frequent in cases where the organ is enlarged, as in leukæmia   Adhesions to the parietes are not infrequently associated   In cases of tuberculous peritonitis the capsule of the organ often shows characteristic tubercle granulations

Acute Inflammation of the Spleen Substance. — Micro-organisms circulating in the blood stream are very apt to be strained off in their passage through the spleen. Hence in conditions such as pneumonia and typhoid small colonies of the causal germ are frequently to be found in the spleen pulp   These may or may not be associated with small foci of necrosis   On the other hand, anything in the nature of large centres of acute inflammation are rare   This is no doubt due to the large amount of blood which the organ contains, germs not multiplying readily in blood itself   The appearances in such spleens have already been discussed under acute congestion   Occasionally in septic infarction an approximation to suppurative softening may occur

Chronic Interstitial Splenitis. — This condition, associated with enlargement and increase in consistence owing to

fibrosis, is met with in a variety of diseases, such as chronic venous congestion, lymphadenoma, leukæmia, and malaria The increase in the fibrous tissue varies greatly in extent and position   It is always found in the trabeculæ and capsule as well as round the vessels   In lymphadenoma it is found chiefly in the Malpighian bodies, in leukæmia mainly in the pulp   In all there is a tendency to pigmentation in connection with the growing fibrous tissue   The lymphoid elements tend to disappear while the endothelial cells increase in number

Tuberculosis of the spleen is invariably associated with tubercle elsewhere   Two types of the condition occur (1) The commonest form is *miliary tuberculosis* associated with generalised infection   The organ is usually not much altered in size   Scattered through it are numerous minute grey, white, or yellow points, which are often difficult to distinguish from Malpighian bodies

Microscopically, there are found tubercle follicles with giant cells and surrounding epithelioid cells, or centres of commencing caseation

(2) The other form of tuberculosis in the spleen shows large, rounded, opaque white or yellow caseous masses scattered through the organ, the so-called ' hard bake " spleen, from the resemblance to almond toffee (Fig 33) This variety is found chiefly in children

Lymphadenoma or Hodgkin s Disease (also known as **Pseudoleukæmia**) — This is a disease primarily of the lymphatic glands (p 122)   The spleen is, however, very constantly affected, especially in advanced cases   When affected the organ is almost invariably enlarged   The enlargement is uniform, although there may be projections on the surface   On section, numerous opaque, pale bodies, angular in shape and more or less uniformly distributed

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(Fig 35), are to be seen   Sometimes they are grouped into masses (Fig 36)   At first grey and somewhat translucent, they become more opaque white in the later stages, and stand out in marked contrast to the general colour of the spleen, which is pink to dark red   The whole appearance of the cut surface is compared to masses of suet in a pudding

Microscopically, the appearances are essentially those seen in the lymphatic glands.   The change is primarily in the Malpighian bodies, which in the early stage show merely hyperplasia of the lymphocyte cell elements.   Soon the large spindle-shaped endothelial cells appear, many of which are multi nucleated, while the lymphocytes diminish in numbers   The large endothelial cells tend to pass into the pulp, and as they are actively phagocytic they take up red cells, and later show hæmatoidin pigment.   Fibrosis commences at a comparatively early stage, and later the Malpighian body may become entirely transformed into a knot of well developed fibrous tissue.   Not infrequently areas of necrosis occur, as in the lymphatic glands.

For changes in the spleen in the various blood diseases see under leukæmia, etc

Tumours of the spleen are rare

Angiomata and angiosarcomata, the latter with secondary deposits in the liver, are described

Secondary tumours are also rare, sarcomata being occasionally found

EXAMINATION OF THE SPLEEN REMOVED FROM THE BODY

Note in the first instance the size of the spleen   The normal organ measures about 5 inches by 3 (12·5 × 7·5 cm.), and the weight is 5-8 oz (150-250 gm.)   If the spleen is enlarged, note whether this enlargement is uniform, the organ retaining its normal shape, or localised   The spleen is uniformly enlarged in acute congestion, chronic venous congestion, amyloid disease, lymphadenoma, leukæmia, malaria, etc.   It is irregularly enlarged in some cases of lymphadenoma, in

tumour and cyst formations   It is diminished in size in the atrophy of old age and in wasting diseases.

Examine the surface for thickenings of the capsule, peritoneal tubercles, evidence of infarction, etc.   Determine the consistence   The normal organ is moderately firm.   In acute congestion it is soft, in chronic venous congestion, waxy disease, lymphadenoma, and leukæmia the consistence is increased.   After making a longitudinal incision into the organ, note whether the edge of the cut becomes rounded, as is the case when the consistence is soft, or remains sharp, as is the case when the consistence is increased   Examine the cut surface for the relative prominence of the Malpighian bodies (these are usually much more obvious in children than in adults), for hæmorrhages, infarcts, opacities, etc.   Note the general colour of the organ, which normally is brownish purple.

DISEASES OF THE THYROID GLAND

There is no organ of the body in which size and weight vary so greatly as in the case of the thyroid gland   This is due to the widespread prevalence of an enlargement usually termed goitre or bronchocele   This enlargement occurs both in a sporadic and an endemic manner   It is difficult therefore to give a normal weight for the organ at any age   It is stated that the normal adult gland should not weigh more than 25 30 gm (about one ounce)   The gland is larger in females than in males, and it undergoes an increase in size during menstruation and pregnancy

Accessory thyroid tissue sometimes occurs, usually in close contact with the main gland, occasionally behind the sternum, where a goitrous enlargement may lead to pressure effects These accessory glands must not be confused with the para thyroids, which are distinct organs with a function of their own.

Aplasia or congenital absence of the gland results in congenital myxœdema characterised by dwarfism and idiocy.

Instead of the two lobes of the gland are found nodules with mucus-containing cystic spaces

Atrophy of the gland in infancy gives rise to the sporadic form of cretinism, and in adult life to myxœdema. Endemic cretinism is associated with a goitrous enlargement of the gland. It occurs in the regions in which goitre is common, especially in the valleys of the Alps and Himalayas. The Cretin is a dwarf in whom the growth of the skeleton is especially arrested. The skin is dry and the hair tends to fall out. The subcutaneous tissue is swollen, leading to pallor and puffiness of the face. The nose is depressed. The abdomen is prominent, and pads of fat are present over the clavicles. There is usually arrest in the development of the brain with resultant idiocy, but cases occur in which the mentality is not greatly affected. As stated above, the sporadic form of the disease is associated with congenital absence or early atrophy of the thyroid. The pathology therefore is the same as in myxœdema, *i.e.* the disease is due to hypothyroidism, and cases rapidly improve under thyroid treatment. The pathology of the endemic form is not so clear. There is usually a goitrous ancestry to be traced, and the condition is closely related to that disease, occurring as it does in the goitrous areas.

Myxœdema is a syndrome which comes on as a result of removal by operation or destruction by disease of the thyroid gland. The individual suffering from it presents a very characteristic picture. The mentality is sluggish. The face has a bloated appearance, the colour is pale yellow, while there is a malar flush. The lips are thick and the tongue large. Pads of fat form below the clavicles, and the subcutaneous tissue generally is soft and mucoid in type (hence the name myxœdema), and there is atrophy of the skin structures such as sebaceous glands and hair follicles. The heart-beats are diminished, and the temperature is low.

Such individuals exhibit a marked tendency to infection, notably to tuberculosis, moreover they show a disturbance of carbohydrate metabolism, so that it is almost impossible to produce glycosuria (increased sugar tolerance)   The thyroid gland is greatly reduced in size and is characterised by a fibrous atrophy in which only a few gland acini are to be found   This fibrous atrophy may be preceded by a goitrous enlargement or by an inflammatory process   Very often in elderly people the arteries of the gland exhibit a calcareous degeneration   Whether this is the cause or the result of the glandular atrophy it is impossible to state   The actual cause of the atrophic change is therefore obscure

Waxy Degeneration occurs occasionally in the diseases which cause amyloid deposits   It is associated usually with a goiterous enlargement   The amyloid change is found in the walls of the vessels and in the basement membrane of the gland acini

Calcareous Degeneration is a frequent complication of goitrous enlargement

Hypertrophy —Under this heading the various types of enlargement of the thyroid commonly known as goitre, struma, or bronchocele may be considered   At the same time it should be stated that there is no very clear line of distinction between these conditions and tumour formations   The enlargement is one which occurs sporadically in most parts of the world, but is much more frequently met with in certain more or less well-defined districts characterised, as regards the geological formation by limestone deposits   Such districts to be found in the Alps and Himalayas in the basin of the Great Lakes in Canada and the United States, and in Derbyshire, England   It is generally recognised that the medium of transmission for the disease is the water supply   Deficient ingestion of iodine will undoubtedly produce the disease, and administration of small quantities

of iodine to school children will as certainly prevent it.
There are those who regard the condition as due to an
infection of the alimentary tract

The pathology of the disease may be stated as follows
Under certain stimuli the thyroid gland undergoes enlarge-
ment due to hyperplasia of its gland elements In this state
the colloid disappears from the gland alveoli, the lining
cells assume a columnar instead of a cubical shape The
walls of the alveoli are thrown into folds owing to increase
of gland cells and stroma The stimuli which cause this
hyperplasia may be physiological, *e g* ingestion of certain
foods, menstruation, pregnancy (it should be noted that
goitre is much more common in females), or pathological, *e g*
infective diseases generally, deficient ingestion of iodine, and
the influence of certain others of the endocrine glands, notably
the suprarenal On the removal of these stimuli the gland
passes into a resting stage in which the alveoli become again
distended with colloid, and the epithelium cubical instead of
columnar *If the stimulus has been excessive, numbers of
the alveoli may be permanently enlarged and cystic* In this
way two types of goitrous enlargement are explained

1 *Parenchymatous*, best exemplified in exophthalmic
goitre, representing the stage of stimulation (for description
see below)

2 *Colloid* or *gelatinous* goitre, the common type of
enlargement met with in goitrous areas, representing the
resting stage following stimulation The enlarged thyroid of
the goitrous area often shows a mixture of the two types
Such a thyroid is the product of repeated periods of stimula
tion followed by resting periods *Complications such as
hæmorrhage, necrosis, cyst formation, fibrosis, and calcifica
tion are common in goitrous thyroids* The cysts may be
hæmorrhagic, necrotic, or merely due to excessive distention
of alveoli In this way the advanced form of colloid goitre is
produced The enlargement may be uniform, more frequently

one side is larger than the other   The surface is nodular
owing to the presence of cysts   On section the cut surface has
a reddish brown glistening appearance with larger cavities con
taining colloid mixed with blood   Areas of fibrosis occur often
with opaque white calcareous deposit and even bone formation

3 *Adenomatous goitre*, characterised by the occurrence
of more or less well-defined rounded nodules pressing aside
the glandular substance of the organ   These nodules are
commonly regarded as tumour formations (adenomata),
although a similar appearance is produced by nodular
hyperplasia   Two types are distinguished (a) the *fœtal
adenoma*, so named by Bilroth owing to their resemblance
to the fœtal gland in structure, the alveoli being small, con-
taining little colloid, and the stroma poorly developed   These
are frequently multiple, soft, and of a greyish red colour, (b)
colloid adenoma, resembling the colloid gland in appearance
and differing only in forming rounded masses pressing aside
the surrounding gland tissue   These tumours are subject
to the same complications—hæmorrhage, cyst formation,
calcification—as the colloid type of goitre

Exophthalmic Goitre (Graves' or Basedow's disease) is
a condition characterised in addition to the enlarged thyroid,
by protrusion of the eyes, increased rapidity of heart's action,
flushing, sweating, and tremors   The thyroid gland is very
vascular and pink in colour   The enlargement is uniform,
the organ retaining its shape   On section the most striking
change is a relative absence of colloid, although in goitrous
areas an admixture with the colloid goitre is common   The
surface has more the appearance of a gland such as pancreas,
owing to absence of colloid   Cysts may be present, but their
content is mucinous rather than colloid

The most striking alteration under the microscope is
the relative absence of colloid in the gland alveoli, which
therefore appear to be collapsed   Instead of the colloid which
stains with the acid dye there may be a small quantity of

granular material often staining with the basic dye The epithelial cells are columnar instead of cubical Projections of stroma covered with epithelium occur in the alveoli, which thus vary very much in shape   There is often shedding of the epithelial cells into the alveoli   The vessels of the stroma are prominent and filled with blood

In fatal cases of the disease, in addition to the enlarged thyroid there may be found enlargement of the thymus gland, endocarditis especially of the mitral valve, pericarditis, enlargement of the spleen, lymphatic and hæmolymph glands, erythroblastic marrow associated with anæmia of a chlorotic type, hypertrophy of the left ventricle of the heart.

The condition is a hyperplasia of the thyroid gland, a parenchymatous goitre as stated above, in which the stimulus to increased action is as yet unknown   One of the most reasonable suggestions is that it is connected with the activity of the suprarenal gland

Inflammations of the thyroid gland (*Strumitis*) are not very common   They may occur in the course of infective disease such as typhoid fever diphtheria and septicæmias They may be due to extension of an inflammatory process from neighbouring parts   Larger or smaller abscesses may form and the condition may be followed by fibrosis and fibrous atrophy   Chronic inflammatory processes are met with in syphilis and in tuberculosis   Any of these chronic changes may produce the fibrous atrophy of myxœdema.

Tumours.—These have been dealt with in part under the heading of hypertrophy   Simple *adenomata* are among the commonest   They occur chiefly in relation to goitrous enlargement   It is difficult to draw a line between them and nodular areas of regeneration   The fœtal adenoma already mentioned is believed by many to arise from embryonic rests situated in the stroma of the gland (Wolffler)   *Papillary adenomata* occasionally occur   Other simple tumours— *fibroma, osteoma,* and *teratoma*—are rare   *Carcinomata* are

fairly common, especially in glands the seat of goitrous enlargement Such tumours are peculiarly apt to metastasise in bones, more especially those of the face and thorax They may be spheroidal cell, acinous, or papillary in type *Sarcomata* of various types occur Hæmangiosarcomas and endotheliomas are described as comparatively common

DISEASES OF THE PARATHYROID GLANDS

The parathyroids, of which there are usually two on each side in close contact with the thyroid gland, are minute glands 6-7 mm in diameter, with a red brown or yellow brown tinge They consist of masses of epithelial cells with occasional colloid containing alveoli Two types of these cells are distinguished, viz *chief* cells and *oxyphil* cells Supporting these there is a vascular stroma Excision of all four glands gives rise in animals to fatal *tetany* A similar condition may be produced in man by extirpation The chief symptoms in tetany is a contraction of the muscles which in man is tonic in type

Little is known about the pathological anatomy of the glands Hæmorrhages into the glands are probably the most important pathological conditions These sometimes occur at birth, probably through injury On healing the condition may be followed by symptoms of tetany

Hypertrophy of the glands occurs after experimental removal of the thyroid gland It also occurs in osteomalacia and other diseases

Tumours are rare They are usually simple adenomas, and are often discovered quite accidentally at autopsy

DISEASES OF THE THYMUS GLAND

Like the thyroid this gland varies considerably in size, but the variations are chiefly physiological, depending upon the age of the individual

At birth the weight is about 13 gm, from the first to the fifth year about 23 gm, from the sixth to the twentieth year about 25 gm, and from then onwards the gland atrophies until after the thirtieth year it is scarcely possible to weigh it with any degree of accuracy If after this age the gland is easily demonstrable a pathological condition is present.

Atrophy —As stated above, after the period of sexual maturity the gland undergoes a process of progressive atrophy This is more than a mere wasting of the gland It is due to a disappearance of the tissue proper, particularly the cortex, with a relative increase in fibrous stroma. In children in diseases associated with wasting in starvation, and in chronic infections such as tuberculosis and syphilis, an atrophy particularly of the lymphatic tissue is observed The Hassal corpuscles become more prominent on account of the disappearance of the intervening tissue This is accompanied by an increase in the connective tissue

Hypertrophy — Under this heading may be mentioned arrested involution of the gland or persistent thymus as well as actual enlargement Hyperplasia of the gland tissue is stated to occur in a large proportion of cases of exophthalmic goitre, in Addison's disease, acromegaly, and in myasthenia gravis The relationship of this enlargement to these diseases is still obscure In a number of cases of unexplained sudden death the gland has been found to be persistent or actually enlarged. In a few cases the enlargement has been sufficiently great (twice the normal or more) to explain death by the interference with respiration In many no such considerable enlargement is present, and some pathologists believe (although actual proof is wanting) that there is some connection between the enlarged gland and sudden death

This persistent or enlarged thymus gland is connected with the condition known as status lymphaticus or thymolymphaticus (see p 123)

Hæmorrhage —Punctate hæmorrhages are frequently observed in the thymus of the new born child   Similar small hæmorrhages occur in young children dying of infectious diseases such as pneumonia   Larger hæmorrhages also occur in the new born, and are specially frequent in congenital syphilitics

Inflammatory conditions of the thymus are not un common   Pyæmia abscesses, syphilitic gummata, and tuber- culous lesions all occur   Occasionally the enlargement associated with these conditions may seriously interfere with respiration

Tumours are rare   It is questionable whether the *lipoma* occasionally found in the anterior mediastinum has anything to do with the gland itself   *Cysts* are not infrequent and *myxomata* are described, but the most important tumours are malignant   Such tumours are usually composed of round cells which resemble the larger cells of the thymus cortex They were originally described as sarcomas, but it is probable that they are epithelial in nature   These tumours rapidly metastasise by the lymph channels   True sarcomata also occur and teratomata

DISEASES OF THE SUPRARENAL GLANDS

The two suprarenals together weigh eight to eleven gm in the adult   They are heavier in the male than in the female, and relatively much larger at birth than later on in life   The reduction in size after birth is due to a disappearance of the inner cortical layers, apparently to make room for the rapidly developing medulla   Each gland is composed of two organs distinct in origin, structure, and function.   The *cortex*, forming a yellow rim to the glands, arises from a portion of the mesodermal ridge   It is composed of epithelial cells arranged in columns and commonly filled with globules of lipoid material—cholesterine esters and ordinary fats   Beyond the

found almost completely destroyed In by far the larger *number* (75 per cent) the destruction is due to a chronic fibro-caseous tuberculosis, frequently (17 per cent) the only tuberculous lesion in the body Cases have been described in which fibrous atrophy, hæmorrhage, syphilitic gumma, and tumour have been the causes of destruction In about 12 per cent of cases no lesion of the suprarenal is present. In some of these, lesions (inflammatory infiltration, pressure by tumour) of the chromaffin tissue of the sympathetic system (semi lunar ganglia, etc) have been found The question arises as to whether the cortical or medullary lesion is most important. In most cases in which the glands are affected the destruction is almost complete, but it would seem that the medullary portion is the most important. In other words, the disease seems to be due to destruction of the chromaffin tissue of the body either in the suprarenal gland or outside it *Another interesting observation of recent date* is that in a large proportion of cases of Addison's disease a general hyperplasia of the lymphadenoid tissue (status lymphaticus) is present.

Tumours —*Simple adenomas* composed of cortical substance are common. They form small rounded nodules with the characteristic yellow colouring of suprarenal cortex, and are composed of cells differing in no essential point from the normal Growths of an epithelial nature of large size with a similar yellow colouring, but with a tendency to necrosis and hæmorrhage, are also common in the situation of the suprarenal glands Such tumours if removed early may not recur, but if left they metastasise into the lung pleura and other internal organs To this group the term *hypernephroma* has been given They are more common in the kidney than in the suprarenal, and many regard them as originating either from the suprarenal or from embryonic rests in the kidney This view, depending upon their colour and the foamy character

of the protoplasm of their cells, is not now so generally held (see p 290)

Tumours of the medulla are also met with arising either from the nerve elements (neuroblastomas) or from the chromaffin cells (paragangliomas) The neuro blastomas were formerly placed in the categories of round cell sarcomas and gliomas, but the recognition in these of fine nerve fibres has placed them amongst the tumours of nerve origin

DISEASES OF THE PITUITARY BODY

The normal gland is about the size of a hazel nut without the shell The weight in the adult is a little more than half a gramme, during pregnancy it may rise to one gramme It is situated at the base of the brain in the sella turcica of the sphenoid bone, and it is connected with the floor of the third ventricle by a short funnel shaped stalk—the infundibulum This expands into the posterior portion of the body, the pars nervosa, which is mainly composed of neuroglia fibres and cells The anterior portion lies in front of and nearly surrounds the posterior It is much more vascular, and is composed of epithelial cells arranged in a reticulum Some of these cells are large and show affinity for acid dyes such as eosin (acidophil), others are basophil, others again show no special affinity of dyes Between the two lobes is a cleft usually broken up into small isolated spaces in the adult In connection with the posterior wall of the cleft is the pars intermedia of the gland There is no definite line of demarca tion between this and the posterior nervous portion, but it is separated from the anterior lobe by the cleft The pars intermedia is composed of epithelial cells forming acini which may contain colloid material These acini increase after thyroidectomy

No active principle has been isolated from the anterior

lobe but it probably secretes a substance which passes into the blood and which exerts an important influence upon metabolic processes and growth especially of the skeleton The effect of extracts of the posterior portion is complex, amongst other results is a lowering of the sugar tolerance

It is extraordinarily difficult to study the pathology of the gland owing to the close connection of what are really two distinct organs lying in a small bony space Thus enlargement of the one organ will inevitably compress the other The following statements may be made with a fair degree of probability

1 *Hyperactivity of the anterior lobe before epiphyseal ossification is completed* induces an exaggerated growth of the skeleton and other tissues of the body, the individual becoming a giant (*gigantism*) At the same time there is sexual maturity and a high sugar tolerance In a case of this kind which came to autopsy the hypophysis was small and converted into a cyst Apparently the hyperactivity had passed into an atrophy

2 *Hyperactivity of the anterior lobe in later life* produces the syndrome usually known as *acromegaly* In this condition the bones of the face hands, and feet are enlarged, and the soft parts greatly thickened The lower jaw projects so that the face resembles that of a horse There is abnormal growth of the hair which is long and coarse There may be glycosuria for a time but later on, owing to impaired gland function, there may be high sugar tolerance associated with obesity and sexual impotence Fatal cases of this disease show an enlargement of the gland which may be merely hypertrophy or may be due to an adenoma However, not every tumour of the pituitary is accompanied by symptoms of acromegaly, because such growths may be destructive from the beginning

3 *Inactivity of the anterior lobe commencing before puberty*

causes changes similar to those seen in puppies after hypophysectomy, viz stunting of growth, great obesity, a condition of high sugar tolerance, and failure in development of the sex glands   What is known as Frohlich's syndrome or adiposogenitalis is apparently the analogous condition in the human subject the result of disease   It is a condition characterised by an excessive accumulation of fat, an imperfect development of the sexual organs, also, frequently, polyuria (diabetes insipidus)   In the male the body takes on the feminine hibitus with large breasts, knock knees, and absence of beard

4 *Inactivity of the anterior lobe in later life* is associated with obesity, high sugar tolerance and polyuria   and a gradual loss of sexual function

Owing to its peculiar anatomical situation   enlargement of the pituitary from whatever cause, inevitably produces secondary symptoms of importance   Because of the unyielding bone below and around   enlargement occurs in the first place upwards with bulging of dura mater covering the sella turcica   Soon excavation of the bone occurs by a process of pressure atrophy, the optic nerves become involved at the chiasma, and pressure symptoms appear in connection with the brain

The various causes of enlargement are   (1) *Hyperplasia*, a constant occurrence in pregnancy and after castration   It occasionally occurs in myxœdema, cretinism, and after thyroidectomy   (2) *Struma*, a condition of simple uniform enlargement of the anterior lobe due to proliferation of its cells   All of the three types of cells are present   It is probably a hyperplasia rather than a tumour   It causes enlargement of the sella, but the gland is not adherent to the bone   It comes second to adenoma in frequency in cases of acromegaly and Frolich's syndrome   (3) *Adenomas* occur in the anterior lobe in its central portion   They vary much in size and may or may not lead to an enlargement of the

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gland as a whole They are composed of epithelial cells conforming to one of the types normally present These tumours are present in the large proportion of cases of acromegaly (4) Carcinomas originate also in the anterior lobe They invade and erode the bone but do not as a rule produce metastasis They are occasionally present in acromegaly and in Frölich's syndrome The structure differs in different cases, and often in different parts of the same tumour (5) Sarcomas of various types are occasionally met with, and also account for a proportion of cases of acromegaly and Frölich's syndrome They are often difficult to distinguish from the carcinomas (6) Cysts originating from the cranio-pharyngeal duct are not infrequently found in cases of Frölich's syndrome (7) Teratomas and metastatic malignant growths are rare causes of enlargement Other lesions of the pituitary occasionally met with are pyogenic foci, gummata, and tuberculous lesions These are rarely associated with symptoms referable to the gland Embolism and infarction are not uncommon occurrences, and may cause symptoms such as are associated with destruction of the anterior lobe

DISEASE OF THE PINEAL GLAND

Little is known of the function of this gland, although apparently it belongs to the endocrine group It is about half the size of the pituitary, and is relatively larger in children than in adults and in the female than in the male. After puberty the gland undergoes retrograde changes, although its epithelial elements persist into old age Small rounded masses of calcareous material are constantly present and tend to increase as age advances

The only important pathological condition hitherto recognised is tumour formation The commonest tumour is a teratoma, which always occurs in young males, and which may produce abnormal growth of the skeleton, sexual precocity,

and early development of secondary sex characters. Marked
increase of subcutaneous fat is also usually present. Other
tumours not commonly associated with the above symptoms
are gliomata and carcinomata. Cysts are also occasionally
met with.

CHAPTER VII

DISEASES OF THE NOSE AND ASSOCIATED CAVITIES

Inflammation. — Although unimportant in itself, inflammation of the nasal cavity or rhinitis may assume importance through extension of the inflammatory process to the accessory sinuses such as antrum, frontal, ethmoidal, and sphenoidal sinuses, also by way of the Eustachian tube to the middle ear and mastoid antrum Such cavities should be examined at the autopsy in the way indicated (p 42) The commonest one to show pathological change is the middle ear, and this should invariably be investigated Acute inflammation is at first of a catarrhal type with secretion of much watery mucus. In the more intense inflammations fibrin occurs and the exudate becomes tenacious and difficult to get rid of As the process subsides leucocytes in large numbers emigrate from the vessels, the exudate becoming thicker and more opaque In such situations as the antrum, tenacious or thick exudate may obstruct the exit and an abscess or empyema result.

Hyperplasia of lymphoid tissue or adenoids is a common condition in the naso-pharynx, especially of children.

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It is associated with repeated attacks of rhinitis, and causes obstruction to nasal respiration with consequent mouth breathing, and sometimes malformation of nose and chest Adenoids form rounded pink masses of firm consistence which show on microscopic examination the ordinary structure of lymphoid tissue. Occasionally they are the seat of a tuberculous infection

Tumours —The commonest tumour in this situation is the nasal polyp, which, although often classified as a fibroma or myxoma, is probably merely pendulous and œdematous mucous membrane Such growths are often associated with asthma and are frequently multiple Other tumours in this situation are sarcomas and carcinomas, but both are much more common in the tonsillar region

DISEASES OF THE LARYNX

Œdema, also called œdema glottidis —This may be due to the swallowing of boiling water, to acute inflammation in the neighbourhood, e g acute tonsillitis It may also occur in association with kidney and heart disease The parts most affected are the posterior surface of the epiglottis, the aryteno-epiglottic folds, and the false cords The condition is serious, from its interference with respiration. It shows itself by swelling of the parts affected, which are pale and have a translucent appearance.

Laryngitis —Acute and chronic catarrhal conditions of the larynx show little that is obvious after death There may be hyperæmia and collection of mucus

Membranous Laryngitis — This is most commonly diphtheritic in origin, although it may be due to streptococcal infection It may occur in the course of other specific

fevers, such as typhoid and smallpox. It occasionally is caused by the presence of foreign bodies, such as fish bones. The membrane usually occurs also over the tonsils and pharynx, and may spread downwards into trachea and bronchi The membrane is commonly *firmly adherent* in the pharyngeal region In trachea and bronchi it is easily removable (Fig 44) The membrane has a white or grey appearance, and the subjacent tissue and surrounding parts are acutely congested

Tuberculosis of the Larynx.—This condition is usually secondary to pulmonary tuberculosis It is characterised by the deposit of tuberculous granulations, with subsequent ulceration The ulcers are found over the epiglottis, aryteno-epiglottic and inter arytenoid folds At first superficial, they tend to extend deeply, eroding the vocal cords, and even the cartilage in the neighbourhood The margins of the ulcers are raised and nodular

Syphilis of the Larynx.—This may occur both in hereditary and in acquired syphilis, and both as a secondary and tertiary manifestation In the secondary stage catarrhal inflammation and mucous patches occur, in the tertiary stage gummata, ulceration, and subsequent cicatrisation and stenosis Ulceration, when it occurs, tends to destroy cartilage as well as soft parts, such as the base of the tongue and pharynx

Tumours of the Larynx.—Among simple tumours, papillomata and fibromata occur Of malignant growths, carcinomata are more common than sarcomata.

DISEASES OF THE BRONCHI

Asthma.—Although not commonly a serious disease, asthma does occasionally prove fatal In such cases the

bronchi are found contracted and blocked by tenacious
plugs of mucus which on microscopic examination show, in
addition to shed epithelial cells, large numbers of eosinophile
leucocytes   The Curschmann's spiral is an elongated plug of
this kind   The lungs generally show an extreme condition
of emphysema, and the other organs of the body are intensely
congested.

Microscopically, the mucous membrane of the bronchi is
folded through a contraction of the bronchial muscle.   There
are found in this way deep indentations or diverticula.   The
basement membrane is hypertrophied, the epithelium shed,
and the subepithelial tissue intensely congested and infiltrated
with eosinophile leucocytes

Acute Bronchitis — Inflammation of the bronchi may
be caused by many different organisms, *e g* *staphylococci*,
streptococci, pneumococcus micrococcus catarrhalis In
addition, irritating fumes, such as those of ammonia, may
produce it   Inflammatory conditions of the smaller bronchi
are often accompanied by inflammation in the contiguous
portions of lung (broncho pneumonia)

The appearances in acute bronchitis are swelling and
congestion of the mucous membrane, with the presence of
a fibrinous or purulent exudate   When the bronchi within
the lung substance are affected, squeezing of the lung
expresses beads of purulent material

Microscopic Appearances — The most striking change is
desquamation of the ciliated epithelial cells, which are found
lying free in the exudate along with polymorphonuclear
leucocytes   The basement membrane upon which the
epithelial cells rest is swollen   The underlying vessels are
congested, and the surrounding tissue infiltrated with in
flammatory cells   The cells of the mucous glands are
swollen and granular

Bronchitis due to anthrax infection, known as "Woolsorter's disease, presents certain peculiarities The inflammation is of a hæmorrhagic type, and implicates the bronchial and mediastinal glands and tissue as well as the bronchi themselves Areas of necrosis occur which shows infiltration with polymorphs, red cells, and fibrin The characteristic bacilli are to be found in the secretion in the bronchi, in the bronchial wall, and in the glands The lung tissue itself is not as a rule affected to any extent. It shows merely congestion and œdema

Chronic Bronchitis.—This condition may be organismal, following the acute form, or it may be associated with the occupation, the individual working in an atmosphere in which there are many foreign particles, *e g* carbon, stone, steel, etc. In appearance there may be little alteration from the normal Sometimes the lumen of the tubes is dilated The mucous membrane may be pale or congested Occasionally there may be superficial ulceration There is always a considerable amount of frothy muco-purulent secretion in the tubes, which may show more or less pigmentation from the presence of foreign particles The condition is usually accompanied by emphysema of the lungs, and often by dilatation of the right side of the heart

Microscopically the epithelium, when present, is of a cubical rather than of a columnar type In places the epithelium may be entirely absent The basement membrane is often thickened and the subjacent tissue infiltrated with inflammatory cells of a small, round, lymphocyte like type There is usually overgrowth of fibrous tissue, and structures such as bronchial muscle and mucous glands may be atrophied The lumen of the tubes contains desquamated epithelial cells and polymorphonuclear leucocytes, mixed with strings of fibrinous material.

Tuberculous Bronchitis.—Tuberculous lesions of the larger bronchi are not commonly met with, although tubercles

may develop in the mucous membrane and subsequently ulcerate   Lesions of the smaller bronchi within the lung are common in pulmonary tuberculosis   Peribronchial tubercles may break through into the lumen of the tubes and lead to ulceration   The smaller bronchi not infrequently dilate through weakening of their walls by inflammatory change Such dilatations may form the starting point of cavities

Syphilitic Bronchitis.—Gumma formation, with subsequent ulceration, although uncommon, is met in the larger bronchi, usually at their commencement, and in the trachea at its bifurcation

A number of cases of sudden death from hæmorrhage through erosion of a large vessel (pulmonary artery, left bronchial artery, superior vena cava) by such an ulcer have been recorded

Bronchiectasis, or dilatation of the bronchi, is usually met with in connection with an interstitial pneumonia (tuberculosis, syphilis)   The dilatation may be fusiform or saccular   It is produced by traction on the part of the contracting fibrous tissue in the neighbourhood together with adherence of the lung to the chest wall   A generalised dilatation of the bronchi may follow collapse of a lung

Bronchiolectasis, or dilatation of the bronchioles, is a common occurrence in broncho pneumonia, more especially in children   The walls of the tubes, weakened by the inflammatory process and under pressure from within through coughing, distend   As a rule the amount of distention is small, but in certain cases it may go on to such a degree that large cavities are produced in which secretion accumulates Such a condition has been called " honeycomb lung "

DISEASES OF THE LUNGS

Collapse —A lung which is not consolidated, and which is not held in position by adhesions between the two layers

of the pleura, the moment that the pleural cavity is opened collapses to about one-third of its bulk Such lungs are therefore always observed in this semi-collapsed condition A similar condition, or one which is more complete, may be produced during life by the presence of air in the pleural cavity, or from drops cal or purulent fluid in the sac. In such a case the lung is of a slate-grey colour (Fig 41), anæmic, tough, and sinks in water On squeezing, few or no air bubbles can be expressed from the cut surface If the collapsed condition have persisted for long, there will be overgrowth of fibrous tissue, and sometimes dilatation of the bronchi If adhesions bind portions of the lung to the parietal pleura, the collapse will be partial

Collapse of small portions of lung is often observed *post mortem*, more particularly in the lower and posterior parts of the organ These appear as dark purple areas slightly depressed below the general surface They can be reinflated by pressing air into them from neighbouring parts

Similar small areas of collapse are found *in cases of broncho-pneumonia* They are due to blocking of the smaller bronchi with exudate, and the subsequent absorption of the air by the blood

Localised collapse may also be found in the lung in the neighbourhood of aneurysms or tumours pressing directly upon the lung

Microscopic Appearances —The alveolar walls are relaxed and approximated The vessels are usually dilated There may be evidence of catarrh in the alveoli Increase of fibrous tissue may be observed. The elastic tissue appears to be increased, but that is merely because of the relaxation of the lung substance and the condensation of the fibres.

Atelectasis —This is a condition similar to the above, which may be found in the new born child, but as it is due to want of expansion, the term "collapse," although sometimes used, is scarcely applicable. The condition may be

complete or partial When partial, it is commonest in the lower lobe, especially in its posterior part The organ which is the seat of the change, instead of being pale pink and crepitant, is dark red, tough, and airless If the condition is partial, the area affected is depressed below the air-containing portion The affected portion sinks in water (see p 392)

Emphysema —Two varieties of this condition are found in the lung (1) vesicular emphysema, or over-distention of the air vesicles of the lung , (2) interstitial emphysema, or the escape of air into the fibrous supporting tissue of the lung

(1) *Vesicular Emphysema* —This is a condition of over distention of the lung alveoli caused by (a) forcible distention of the air vesicles from constant coughing, as in chronic bronchitis, or from the blowing of wind instruments , (b) the giving way of the elastic network of alveolar walls before a normal pressure , this may be due to wasting disease, to old age, or to an inherent imperfect development of the tissue The portions of the lung most affected are the apex, the anterior and lower borders, that is to say, those portions where over-distention can occur most readily The lung is pale (Fig 40), light, and has a spongy feel, like the sensation given on pressing a bag of feathers On section, it is dry and bloodless There may be areas of very marked dis tention forming small bladders or bullæ The condition is usually associated with *chronic bronchitis* and *enlargement of the right side of the heart* *Hypertrophic* and *atrophic* forms of emphysema are distinguished , in the former the organ is more voluminous, in the latter it is smaller than usual The hypertrophic type is found in cases where forcible distention from coughing is the cause, the atrophic type in cases of wasting disease in old age, or where the elastic tissue of the organ is naturally imperfectly developed

Complementary or *compensatory emphysema* is found in

small areas of lung in close approximation to areas of collapse or to areas of shrinkage from fibrosis This latter type, found in the neighbourhood of healed tubercle foci, may be called *traction emphysema* (p 182).

Microscopic Appearances —There is marked over distention of the air vesicles and smaller air passages. The smaller vessels have, to a great extent, disappeared. The elastic fibres of the alveolar walls are stretched and widely separated. The bronchi may show evidence of chronic catarrh.

(2) *Interstitial emphysema* is a rare condition when, owing to rupture of the lung from injury (*e g* fractured rib, stab, or bullet wound) or disease (*e g* gangrene, emphysema), the air escapes into the fibrous supporting tissue. In this position it works its way to the root of the lung, and eventually into the mediastinum and areolar tissue of the neck.

CIRCULATORY CHANGES

Acute Congestion or Hyperæmia. —This condition is usually found preceding or associated with inflammation of the lung It will be described in connection with pneumonia

Passive Congestion or Hyperæmia. — Two varieties of this condition may be distinguished

1 *Hypostatic congestion*, a condition frequently found *post mortem*, more especially, in cases where the circulation has been slowly failing As the name indicates, it is in the posterior parts of the lung (the parts where gravity has most influence on the blood) that the condition is most marked The area involved is dark purple in colour, and is often the seat of œdema and inflammatory consolidation

2 *Chronic Venous Congestion of the Lung* —This occurs where there is long-standing obstruction to the passage of the blood through the lungs, as in cases of *chronic valvular disease of the left side of the heart* The organ is of a dark

red, sometimes brick red colour, and in the later stages it is of firmer consistence, hence the term " brown induration " Not infrequently infarcts are present in such lungs

Microscopic Appearances —The vessels appear dilated, and, in the case of the alveolar capillaries, they project into the interior of the air vesicles and are obviously thickened.   Red blood cells may be found free in the spaces, also shed endothelial (heart failure cells) containing pigment derived from broken down red corpuscles   Catarrhal changes will also probably be found in the bronchi and there may be some increase of fibrous tissue, but this is seldom in sufficient amount as to be obvious under the microscope   In the hypostatic variety œdema and more acute inflammatory changes may be present.

Hæmorrhage into the lung substance may occur in the form of minute *petechial hæmorrhages* usually under the pleura.   Such are found in severe anæmias, in cases of death from suffocation, and in infective conditions   Larger hæmorrhages are found in *infarction*, in severe inflammations, and in gangrene , also sometimes in tuberculosis

Embolism of the pulmonary artery is one of the commonest causes of sudden death   In all such cases the main artery and its branches should be carefully investigated for the presence of thrombi (p 25)   This thrombus may come from a varicose vein in the leg, from a uterine vein after parturition, or from a vein in the neighbourhood of some operation area, particularly in the abdomen, *e g* after removal of fibroids from the uterus   Should a large branch of the pulmonary artery be blocked death occurs with startling suddenness, often on the patient sitting up in bed   Blocking of smaller branches does not cause immediate death, so that the changes associated with infarction have time to occur

Infarction (Pulmonary Apoplexy) —This is a common condition to find in lungs the seat of chronic venous congestion   When the area of lung involved is large, the condition may be the cause of sudden death   The causation of the condition is not quite clear, as it is difficult to produce

infarction experimentally by the injection of artificial emboli In a majority of cases, however, the artery leading to the area will be found plugged with an embolus, and on careful examination a source will be found for the embolus, *e g* a thrombus in the right auricular appendix or in a vein (see diagram, p 66) Another view of the causation is that it is due to thrombosis in the vessel, not to embolism Another, that it is merely due to escape of blood from a burst capillary into the spongy tissue of the lung

The condition is more frequently found in the *lower lobes* than in the upper It occurs specially at the *margins* of the lung (anterior and lower) and towards the *surface*, not in the substance

The area involved is more or less angular (Fig 45) It is raised above the general surface of the organ, that is to say, it remains distended when the neighbouring lung undergoes partial collapse It is *usually dark purple in colour and hard in consistence* Occasionally it may be pale from subsequent decolorisation Sometimes a zone of fibrous tissue develops around the infarct, and the area may undergo softening or it may cicatrise Infarcts of the lung, however, seldom show the later changes found in infarcts elsewhere This is no doubt partly due to the fact of the double blood supply of the lung It is also due to the fact that many of the infarcts occur shortly before death, and in some instances are the actual cause of death.

Microscopic Appearances —In the area involved, the alveoli are filled with red blood cells and fibrin, or, in other words, with blood clot There are also leucocytes present, more especially at the margin The cells of the alveolar walls show some loss of staining reaction, but necrotic changes are not frequently found in infarcts of the lung There may also be a development of fibrous tissue round the area.

Œdema.—This is an exceedingly common condition It is found in cases in which dropsy tends to occur elsewhere, as in *heart disease* and in *Bright's disease* It is also very

commonly present in cases where death has occurred slowly, as in *wasting diseases, e g* cancer, anæmia It is frequently com bined with hypostatic congestion, and tends to occur in the more dependent portions of the lung Thus it is more frequent in the posterior portions of the lower lobe Occasion ally, however, it is most marked in the upper lobe. Œdema frequently occurs in the neighbourhood of pneumonic areas The organ is pale unless congestion is superadded It is bulky and feels fairly solid, but, unlike a pneumonic lung, it pits on pressure When one cuts into it and presses the lung substance, frothy fluid escapes

Microscopically, the alveoli are found distended, their contents being finely granular material, which is all that is left of the albuminous exudate after the tissue has been fixed, hardened, and cut. Catarrhal cells and leucocytes are also usually present within the alveoli

INFLAMMATIONS OF THE LUNG—PNEUMONIA

Pneumonia—General Considerations

Irritant particles and pathogenic germs may reach the lung substance by several different channels The most obvious path is of course the respiratory tract. It is, however, by no means an easy matter for foreign particles to enter the ultimate air cells or even the smaller bronchi The greater proportion of them are strained off in the nose and upper air passages. That it is possible under artificial conditions to introduce bacteria and carbon particles into the terminal air sacs has been proved, but under natural conditions the moist walls of the channels, constantly narrowing and frequently changing direction, seize and retain the greater number These retained particles are then wafted upwards by the action of the ciliated epithelium lining the tract, and are eventually expectorated This action on the part of the ciliated epithelium is interfered with and may be suspended as the result of catarrh. Hence probably the increased susceptibility to tuberculosis following such conditions as measles There is, however, a tendency for a bacterial infection, once it is started,

in one part of the tract to spread downwards by continuity of surface. Thus many cases of bronchitis and pneumonia are preceded by a catarrhal process higher up in the tract.

Another avenue by which infection may reach the lung is the lymphatic system. An infection originating in the mediastinal glands and tissue may pass in a radiating fashion into one or more lobes by the lymphatics, eventually implicating the lung substance.

Again, germs may reach the lung by the blood setting up what is known as embolic pneumonia. This is probably not a common avenue of infection, but it occurs not infrequently in pyæmia, particularly that caused by middle-ear disease with subsequent thrombosis in the lateral sinus and that associated with osteomyelitis.

Lastly, germs may reach the lung by direct continuity of tissue, from infections in pleura, liver, peritoneum, rib, neck, etc.

Owing to the peculiar structure of the lung—a honeycomb of minute cavities—inflammation is always associated with consolidation. This consolidation is due to a filling up of the air spaces with some exudate containing cells in larger or smaller quantity. The more intense forms of inflammation, notably those produced by the pneumococcus, are characterised by fibrinous (croupous) exudate infiltrated with polymorphs. A hæmorrhagic exudate is associated with acute influenzal pneumonia. In the less acute types of pneumonia and at the periphery of areas of lobular pneumonia, also in the catarrh of passive congestion, the cell elements are mainly of the so-called catarrhal type. These large mononuclear cells which also occur characteristically in tuberculous pneumonia are derived in part from the lining cells of the alveoli, but also in large part, as has been recently pointed out, from a proliferation of the endothelial cells of the inter alveolar blood vessels

The different types of pneumonia are named partly according to the type of exudate which is associated, e.g catarrhal, croupous (another name for fibrinous), partly according to the distribution, e.g lobar, lobular, partly according to the causal germ, e.g pneumococcic, influenzal, tuberculous.

Of all the organisms found in acute pneumonia, the pneumococcus is the commonest. It occurs either by itself or in association with other germs, such as the influenza virus, pneumobacillus, tubercle bacillus The pneumococcus is now recognised as forming a group of closely allied germs, of which

there are four types   Three appear to be definite varieties and are known as Types I, II, and III   Type III is also called the pneumococcus or streptococcus mucosus, on account of its well-developed capsule   It is a specially virulent type Type IV represents a collection of strains which do not fall into one or other of the first three categories   They are relatively non pathogenic   The strains separated from saliva and normal throats usually belong to this group   Some cases of acute pneumonia such as those following ether anæthesia may be caused by organisms of this type

Types of Pneumonia

A Acute Pneumonia
    1 Lobar pneumonia (croupous pneumonia)
    2 Lobular pneumonia (catarrhal or broncho-pneumonia)
    3 Purulent (septic) pneumonia
    4 Hypostatic pneumonia.

B Chronic Pneumonia
    5 Interstitial, following acute pneumonia.
    6 Pneumonia due to inhalation of dust particles (pneumokoniosis)
    7 Pneumonia due to chronically acting bacterial poisons (tuberculosis and syphilitic pneumonia)

1 Acute Lobar Pneumonia

This condition, also called Croupous Pneumonia, is so well defined that it may be called a specific disease   It is due in the vast majority of cases to the *diplococcus pneumoniæ*   This organism is accompanied not infrequently by *B pneumoniæ*, *streptococci*, *staphylococci*, *B influenzæ*, *B typhosus*   Occasionally these organisms are present by themselves

The condition, as its name indicates, is one which usually involves the *whole or the greater part of the lobe of a lung*   The right lung is more frequently the seat of the disease than the left, and the lower lobe than the upper lobe   Not infrequently the whole of one lobe and a portion of another lobe may be affected, and less frequently both lungs may show the change   Orth gives the percentage of involvement of the two lungs as follows —right, 52 ; left, 33 ; both lungs, 15

The term croupous is applied because of the type of exudate present in the lung alveoli, which is essentially fibrinous

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For reasons of convenience it is customary to divide the process into *four stages* (1) stage of *active hyperæmia* or acute congestion, (2) stage of *red hepatisation*, (3) stage of *grey hepatisation*, (4) stage of *resolution* The distinction between these stages is an entirely artificial one Frequently more than one of them are to be observed in one and the same lung By themselves the first two are rarely seen, owing to the fact that death does not often occur during the early stages of the disease They are, however, not unfrequently seen in areas of the lung in which the later stages are present in neighbouring parts

(1) *Stage of Acute Congestion* —As regards the naked-eye appearances at this stage there is little more to be observed than a bright red colour in the lung substance on section. The lung substance is still crepitant and spongy

Microscopic Appearances —The vessels of the lung generally, and the capillaries in the wall of the alveoli in particular, are distended with blood. This condition of the capillaries gives a beaded appearance to the walls of the air vesicles Within the lumen of the vesicles may be found a few red blood corpuscles, a few catarrhal cells thrown off from the wall, and a minute quantity of exudate Suitably stained specimens may show germs.

(2) *Stage of Red Hepatisation Naked eye Appearances* — The lung is *distended* and contrasts markedly with the semi collapsed condition of the ordinary lung Not infrequently the markings of the ribs may be seen There is usually some slight amount of *fibrinous exudate* over the area of lung involved In consistence the organ is *firm*, like a solid organ such as the liver It cuts hard, quite unlike the soft, yielding, unconsolidated lung The organ is *immensely increased in weight* A small portion removed and placed in water at once *sinks*

The cut surface of that portion of the lung which shows the change has a reddish colour, which, on account of its

being mottled with paler areas and accumulations of black
pigment, has been compared with red granite   Usually
the cut surface, more especially the paler areas, has a *granular
appearance*, owing to the projection of plugs from the alveoli
On squeezing the lung substance, only a little blood and
serous fluid, but no air, can be expressed   Those portions
of lung not actually consolidated may show congestion, and
sometimes œdema

On opening up the bronchi their mucous membrane is
found swollen and injected and their lumen filled with sticky
rust-tinged exudate   The bronchial glands are swollen and
pink in colour

Microscopic Appearances —Instead of the fenestrated
appearance of the normal lung section, the lung which is the
seat of this change appears like a solid organ.   The alveoli
are filled with plugs consisting of a network of fibrin threads,
sometimes communicating with the coagulum in a neighbour
ing vesicle through one of the stomata   In the meshes of the
fibrin are catarrhal cells, a few red blood corpuscles, and con
siderable numbers of leucocytes, chiefly of the polymorpho
nuclear type.   In suitably stained specimens organisms can
usually be found.

In the walls of the alveoli the vessels are still distended
with blood   The bronchi show evidence of acute inflamma
tion   The interlobular septa and the supporting fibrous tissue
of the lung generally are swollen and infiltrated with fibrin and
leucocytes   The pleura shows the changes of acute inflamma
tion.   Films made from the bronchial exudate will show
leucocytes, fibrin, desquamated epithelium, both flattened and
columnar, and characteristic germs   This last is the best
source from which to demonstrate the pneumococcus

(3) *Stage of Grey Hepatisation   Naked eye Appearance* —
The organ is *distended* as before, shows rib markings and
fibrinous exudate on the pleura over the affected lobe   As
before, it is *firm, heavy*, and a portion removed sinks in water
The cut surface, however, is *pale*, and, with the black mottling
of the carbon, is not unlike grey granite in appearance (Fig 42)

The *granularity* of the cut surface *is more marked*, and, on scraping the surface with a knife, turbid fluid and plugs from the alveoli can be removed On squeezing, similar fluid can be expressed, but *no air-bubbles* On opening up the bronchi the mucous membrane, as before, is found to be swollen and injected, the contents have a more opaque white appearance.

Microscopic Appearances—The alveoli and smaller air passages are filled, as before, with plugs, which are, however, at this stage retracted from the walls, this space having been filled during life with fluid The fibrin threads are not so obvious, they are broken down and granular In the meshes of the coagulum are vastly more numerous cells, the increase being entirely due to the accumulation of polymorphonuclear leucocytes Many of these stain badly owing to degenerative changes Germs are often difficult to find at this stage The capillaries in the walls of the alveoli are, to a large extent, obliterated by the pressure of the contents of the air vesicles Bronchi, interlobular septa, and pleura show, as in the earlier stage, evidence of inflammation

(4) Stage of Resolution *Naked eye Appearances*—The lung is still somewhat distended, but is now much *softer* From the cut surface *considerable quantities of grey, milky fluid* can be expressed

Microscopic Appearances—The alveolar plug is contracted still more, and may be absent altogether The contents of the alveoli are granular material and degenerated leucocytes Multiplication in the endothelial cells of the alveoli is often seen, as evidenced by their greatly increased number These may be found surrounding the remains of the plug The capillaries of the alveolar walls are again distended with blood.

Other terminations than resolution in the case of lobar pneumonia are (1) *septic softening*, which may go on to *gangrene*, (2) *fibrosis*, or overgrowth of the fibrous support ing tissue of the lung, producing chronic interstitial pneumonia.

In carrying out a *post mortem* in a case of acute lobar

pneumonia, the following conditions, more especially, should be looked for in organs other than the lung —

(1) A leucoblastic condition of the bone marrow associated with the marked polymorphonuclear leucocytosis of the blood in the disease

(2) Acute congestion of the spleen

(3) Cloudy swelling of liver, kidneys, and heart muscle

Other conditions which may complicate the disease are ulcerative endocarditis, pericarditis, meningitis, peritonitis

2 Lobular Pneumonia

Synonymous terms for this condition are (1) *broncho-pneumonia*, from the fact that areas of lung in connection with, and around bronchi are involved, (2) *catarrhal pneumonia*, from the character of the exudate most characteristically found in the alveoli

The etiology of the condition may be said to be the same as in the lobar form of pneumonia It is *more frequent in children*, and is the form of inflammation of the lung found in the specific fevers The matter might be put in this way, that pneumococcic infection of the lung in children usually shows the lobular type When the lobular type occurs in adults, the causal germ is usually some other organism than the *pneumococcus*, e g *streptococci, staphylococci*

Naked-eye Appearances —The lung may be slightly more distended than normal It has a *mottled*, red surface, with (1) dark purple depressed areas of collapse, (2) red, firm areas of consolidation, and (3) pale areas of compensatory emphysema On handling it, *irregularly scattered areas of a firmer consistence* than the rest can be felt On section, the same mottled appearance is visible, with dark purple areas of collapse where a bronchus has become plugged, pink areas of consolidation, more or less rounded (Fig 43), in the centre of which can often be seen a small bronchus, from

which, on squeezing the lung, a small bead of thick white secretion can be pressed, also paler emphysematous areas The lung tissue generally is congested On opening up the bronchi, their mucous membrane is found swollen and congested, with more or less purulent looking secretion The bronchial glands are congested and swollen The smaller bronchi and bronchioles within the lung substance are not infrequently dilated, sometimes to such an extent that a "honeycomb" appearance is produced (see Bronchiolectasis)

Microscopic Appearances —To realise the true nature of the change, large sections of lung should be cut The consolidation will then be seen to be patchy in its distribution, the plugged alveoli being usually situated round a small bronchus or bronchiole as their centre This bronchus shows the *appearance of acute bronchitis, and its wall is infiltrated with inflammatory cells* The elastic coat may be ruptured, and not infrequently the lumen is dilated The alveoli around contain plugs which may be more fibrinous or more leucocytic, *the appearances varying considerably in different types of the disease and in different positions* Towards the margin of the area more of the cells filling the alveoli are of the catarrhal type, *i e* they are cast off, swollen endothelial cells Hence the term "catarrhal pneumonia" The walls of the alveoli generally show congestion of their vessels

Broncho-pneumonia may resolve or may pass into septic pneumonia or gangrene The associated changes in spleen, bone marrow, etc , are the same as in lobar pneumonia

3 Purulent or Septic Broncho-Pneumonia

This condition may occur —

(1) As a sequel to broncho-pneumonia, especially when of the so-called *aspiration type, e g* associated with the inhalation of septic material, as after operations on the mouth

(2) Associated *with obstruction to the bronchi, as by tumour or aneurysm leading to retention of secretion* (so-called "retention" pneumonia)

(3) Associated with the presence of a *foreign body* in the bronchi.

(4) As a *blood infection* due to the deposition of organisms or infective thrombi in the pulmonary vessels (*embolic or metastatic pneumonia*), found specially in such conditions as osteomyelitis and pyæmia   Septic *infarcts* are not infrequently associated   Such infarcts have the same distribution and often very much the same appearance as the non septic type (see p 157), but they tend to be paler and often show softening in their centre   Under the microscope such infarcts are characterised by immense numbers of polymorphonuclear leucocytes in addition to red blood cells, also by masses of organisms

In all the above the appearances are the same as in broncho-pneumonia, but the inflammatory changes are more acute, and there is a greater tendency to destruction of pulmonary tissue   The bronchi are filled with purulent material

Abscess —A true lung abscess, defined as a suppurative inflammation involving the lung substance, is comparatively rare   It arises either as a suppurative softening of a pneumonia, lobar or lobular, or as a blood infection due to the lodgment of an infective embolus   Such abscesses are commonly small   They are surrounded by a zone of consolidated lung and show ragged irregular walls   They usually pass on into gangrene   In addition to the above there may be included under the term, cavities which form in relation to foreign bodies impacted in a bronchus, also localised empyemas rupturing into the lung   Bronchiectatic and tuberculous cavities are in a sense abscesses, but they are not usually classified as such

Gangrene — This is usually a *secondary condition*, the result of putrefactive organisms reaching a consolidated or necrosed portion of lung   Thus it may follow *lobar* or *septic pneumonia*, *infarction* or *abscess*   It may also be due to *direct extension*, as from a ruptured ulcer of the *œsophagus*, or from a subphrenic abscess   It may be due to the *presence of foreign bodies* in the bronchi, such as coins or false teeth

The area involved is at first intensely congested, later it

becomes black, and the lung substance breaks down and comes away, leaving a cavity (Fig 46) lined with black or greenish black walls, the colour being due to changes in the effused blood. The contents of these cavities and of the bronchi are usually brown, like prune juice, but may be paler, like pus or putty The neighbouring portions of lung show pneumonic consolidation The odour is always most offensive.

4 Hypostatic Pneumonia

This is a type of pneumonia associated with hypostatic congestion and œdema of the lungs, and therefore found in the posterior and lower portions It is the type of inflammation which supervenes in old age, and in wasting diseases generally

The distribution of the change allows of immediate recognition The consolidation is usually partial and associated with œdema

Microscopically the appearances differ in different parts— congestion, œdema with catarrhal, fibrinous, and leucocytic consolidation, *all being found in close contact.*

5 Interstitial Pneumonias

These are conditions in which there is increase in the fibrous tissue of the lung They may be divided into three groups :—

    (1) Those *following previous acute pneumonia*

    (2) Those *due to the inhalation of dust* of various kinds

    (3) Those *due to chronically acting bacterial poisons*, tuberculosis, syphilis, actinomycosis

Interstitial Pneumonia following acute lobar or lobular pneumonia is a comparatively rare condition. It usually shows itself as localised areas of thickening of pleura and inter-lobular septa also of the fibrous tissue at the root of the organ Sometimes it is more diffuse, involving considerable areas of lung tissue In this condition, as in other types where there is marked thickening of the alveolar walls, the endothelial cells of the alveoli may become cubical

Interstitial Pneumonia due to the Inhalation of Dust

(Pneumokoniosis) —There are three common varieties of this, according to the kind of dust inhaled :—

   (1) *Anthracosis* or coalminer's lung

   (2) *Silicosis* or stonemason's lung, also known as *Chalicosis*

   (3) *Siderosis* or needle-grinder's lung

In all these conditions the foreign particles which are inhaled are absorbed into the lymphatics, partly by the action of phagocytes They tend to be deposited along the course of the lymphatics, and there to set up irritation and consequent fibrosis Thus nodules of fibrous tissue develop beneath the pleura, along the interlobular septa, bronchi, and vessels The lymph glands at the root of the lung are enlarged and indurated   Owing to the irritant action of the foreign particles preparing the way for germs, tuberculosis is a very common accompaniment of all these conditions They are also frequently complicated by chronic bronchitis and emphysema, and by a degree of catarrhal pneumonia, and occasionally by bronchiectasis The siliceous particles are more irritating than the carbon, hence the nodules of fibrous tissue tend to be larger in silicosis than in anthracosis , there are also more catarrhal changes in the alveoli The steel particles are more irritating than the siliceous, hence the changes are most marked of all in siderosis.

Anthracosis —There is always a certain amount of pigmentation in the lung of town dwellers and also in most country dwellers   This is enormously accentuated in those who work in coal mines   When well marked the condition is known as anthracosis   The lung is usually black, or almost black, with small, hard, black nodules scattered under the pleura and in the lung substance *(Fig 48)   On* squeezing, there exudes an inky black fluid   The bronchial glands are enlarged, deeply pigmented, and indurated

Microscopic Appearances — The nodules are found to consist of well formed fibrous tissue mixed with carbon

pigment. They occur under the pleura, along the interlobular septa, bronchi, and vessels. The superficial layer of the pleura is, however, free from pigment. There is some degree of catarrhal change in bronchi and alveoli, and some thickening of the vessels.

Silicosis.—The lungs in this condition are grey in appearance, and, scattered through them, are numerous grey nodules, which are hard and gritty to the touch. Similar nodules are present in large numbers under the visceral pleura. They tend to be larger than those in anthracosis (Fig 47)

The disease is not unlike the more chronic forms of tuberculosis, and, as already pointed out, it is not infrequently complicated by it. The pure condition may be distinguished from tuberculosis by the hard and gritty character of the nodules and by the absence of cavitation

Microscopic Appearances.—These are the same as in anthracosis but the pigment is not so obvious (although carbon pigment is also present) and there is more catarrhal change in the surrounding lung. There may be endarteritis obliterans of the vessels. Tuberculosis is often superadded.

Siderosis.—The nodules in this type are larger, owing to the greater irritation of the metal particles. The lungs have a grey appearance and may be almost solid. Evidence of tuberculous disease is very frequently present in addition.

Microscopically, in addition to the larger areas of fibrosis, there is more catarrhal change in the alveoli, between the nodules of fibrous tissue.

Syphilitic Disease (a) *White Pneumonia*—This is a condition occasionally found in children suffering from congenital syphilis. The lungs are pale and firmer than normal.

Microscopically, there is found an overgrowth of fibrous tissue involving the walls of the individual alveoli. The endothelium lining the alveoli is cubical instead of being flattened.

(b) *Gummata* —These occur as small caseous foci surrounded by fibrous tissue They are not infrequently absorbed, leaving puckered cicatrices behind They are indistinguishable from tuberculous caseous masses

(c) *Interstitial Pneumonia* in acquired syphilis occurs as areas under the pleura or towards the root of the lung There is thickening of the pleura, of the interlobular septa, and increase of fibrous tissue around the bronchi and vessels The last usually show endarteritis obliterans

Microscopically, there is overgrowth of fibrous tissue, usually catarrh of the alveoli and often accumulations of small round cells (miliary gummata)

TUBERCULOSIS

Tuberculosis —The lungs are by far the commonest site for tuberculous disease In a large proportion of cases the disease does not progress far and soon heals, leaving merely some cicatricial tissue behind The apex of the lung is the seat of election for the disease Very often the apices of both the upper and lower lobes are affected The *disease may reach the lung* by any of four paths (1) the *air passages*, (2) the *blood vessels*, (3) the *lymphatic vessels*, or (4) by *direct extension* In most cases it is im possible to say by what avenue the disease originally came Nevertheless, certain statements can be made regarding this question of the path of entrance (1) Where the tubercle lesions are uniformly scattered through the organ, the disease has been brought by the blood stream, and search should be made for some older focus of infection in some other part of the body or in the lung itself This focus is commonly a lymph gland which has become adherent to, and eventually has ruptured into, a vein or a large lymphatic trunk, such as the thoracic duct Not infrequently the source is a focus in the lung itself which has invaded a branch of the pulmonary

Characters of the Lesions—The tuberculous lesions tend to occur in the form of isolated foci These may be widely separated from one another, or so closely packed that they are practically continuous They are either grey and more or less translucent when they are formed of cellular elements and fibrous tissue, or opaque white or yellow when these elements have undergone caseation There is always a certain amount of interstitial change or fibrous tissue formation, both in the lesions and in the lung around

In the more acute cases this fibrous tissue formation is minimal In such cases the condition tends to spread diffusely, involving more or less of lung substance and producing a catarrhal consolidation of the alveoli which subsequently undergoes a caseous change (caseous pneumonia)

Microscopically, the tuberculous lesion is characterised by a cell aggregation, the individual cell elements showing two types (1) large multinucleated or giant cell's, the nuclei of which are arranged commonly in a circle, or part of a circle, round a central clear, necrotic area, (2) spindle-shaped and branched cells, with nuclei resembling those of the giant cell, and, arranged round that cell (epithelioid or endothelioid cells), (3) lymphocyte-like cells, with small dark staining nuclei and little protoplasm.

Polymorphonuclear leucocytes are, except in very acute cases, relatively few in number The giant cell is not infrequently absent, and its place occupied by an area where the cells are breaking down This area, as it enlarges loses all appearance of structure. It is the commencement of the caseous process. In addition, there is always more or less overgrowth of fibrous tissue In the more acute cases caseation predominates, in the more chronic, fibrous tissue formation. Where this inflammatory process invades the alveoli there is consolidation of the lung, a consolidation characterised by the presence of some exudate, not as a rule fibrinous, with numerous catarrhal cells and leucocytes. This consolidated area of lung also tends to undergo the caseous alteration whereby it becomes apparently structureless, but in this caseous focus the fibrous

tissues, and more especially the elastic fibres, persist fo~ long almost unchanged.

The elastic fibres of the lung undergo some destruction both by fragmentation and solution, in the area where cells and nuclei are breaking down. The fibres which escape this primary destruction may persist in the caseous area for an almost indefinite period. It is largely for this reason that necrotic caseous areas of lung remain firm. When secondary infection with pyogenic and other forms of microbes occurs, complete destruction of the elastic fibres and softening of the caseous area takes place, the softened material is coughed up, and a cavity results. Another way in which cavity formation not infrequently starts is by inflammation of the walls of a bronchus or bronchiole. The wall, weakened by the inflammatory process, next gives way under the increased pressure associated with coughing Destructive changes then occur, and a cavity results which subsequently extends

Classification of Tuberculous Affections of the Lungs— The most satisfactory classification would probably be upon the basis of the path of infection, but, owing to the fact that in most instances it is practically impossible to be certain of the path of entrance of the disease, owing, further, to the fact that even in a case of probable air-passage infection the disease may spread by the lymphatics, and even by the blood-vessels, this method is not entirely satisfactory. Another method of classification is on the basis of the main underlying histological change As we have seen, there are essentially two such changes in pulmonary tuberculosis: (1) a filling up of the alveoli with exudate and cells (mainly catarrhal), in other words, pneumonia or inflammatory consolidation The consolidated area subsequently undergoes a necrotic (caseous) change This type of lesion is characteristic of the more acute conditions, i e where the virulence of the organism is high or the resistance of the in-tividual low. (2) A laying down of new fibrous tissue usually in relation to pre-existing fibrous tissue (interalveolar, interlobular, etc), i e fibrosis, or interstitial pneumonia This

occurs in cases where the organism possesses a relatively low degree of virulence or where the soil (i.e. the individual) is unusually resistant. The two changes are commonly found side by side, but sometimes the one predominates, sometimes the other

Probably no method of classification is completely satisfactory, but the following has for long been found useful by the author. It has the advantage of describing in general terms the appearance of the lung condition as a whole. It may be regarded as a compromise between the two methods mentioned above

1 *Miliary* or *Disseminated Metastatic Tuberculosis* (as suggested by Orth)

2 *Caseous* or *Tuberculous Broncho-Pneumonia,* or, if diffuse, *Caseous* or *Tuberculous Pneumonia.* This condition may or may not be accompanied by cavity formation. This includes the conditions which are usually described as acute phthisis.

3. *Fibro-caseous Tuberculosis,* again either with or without cavitation This includes the condition known as chronic phthisis

There are objections to the above method of classification, but on the whole it will be found that most types of pulmonary tuberculosis can in this way be satisfactorily described

The method avoids the use of the term 'phthisis,' which is really a clinical one, and not infrequently incorrect at that, meaning, as it does, a wasting disease The terms used merely form a starting ground from which to detail the more minute changes.

I. Miliary Tuberculosis or Disseminated Metastatic Tuberculosis

This condition is usually *blood spread,* but may be spread by the *lymphatics* It is associated with an *older tuberculous*

focus in the lung, bronchial glands, or a lesion in some
other part of the body This primary focus should be sought
for Where the condition is blood-spread, tubercles will be
found scattered through other organs and tissues, if not
large enough to be seen by the naked eye, they will be
found on microscopic examination

Naked-eye Appearance —The lung is uniformly congested
Scattered through its substance are immense numbers of
grey, white, or yellow foci (Fig 49), which may vary in size
from something just visible to an area one or two millimetres
in diameter Frequently the areas vary in size in different
parts of the lung Sometimes they are found to be larger
in the upper portions of the lung Sometimes the areas are
arranged in groups (staphyloid arrangement) round blood
vessels or bronchi, indicating that the spread has been by
way of the lymphatics Where the distribution is uniform
throughout, spread by the blood stream is most probable

Microscopic Appearances — Scattered through the lung
substance between individual alveoli around bronchi and
blood vessels and interlobular septa, are rounded areas of cell
accumulation. The cells compos ng these are chiefly mono-
nuclear, of the epithelioid and lymphocyte type with catarrhal
cells and a few polymorphs. Sometimes in the centre there are
giant cells, at other times the centre is occupied by an area
where the cells and their nuclei are breaking down Not in
frequently there is a distinct structureless caseous centre. In
specimens stained for elastic fibres there will be found some
destruction of tissue in the central area if they have been included.
In other cases (the more chronic type) the fibres are merely
pushed aside by the aggregating cells.

There is always a certain amount of involvement of the
surrounding lung alveoli. Those alveoli in the immediate
neighbourhood are consolidated with exudate catarrhal cells,
and leucocytes. As this area of alveolar involvement enlarges,
the condition tends to pass into the second type—caseous
broncho pneumonia. There is usually more or less new
formation of fibrous tissue in and around the nodules. In the

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more acute type with necrotic centre this is minimal. In suitably stained specimens tubercle bacilli, although few in number, will be found, more particularly in the acute type. Not infrequently bronchi and vessels will be seen in course of invasion by the nodules. It is this secondary invasion of vessels which largely accounts for the great number of the tubercles, and for their variation in size, due to the fact that they are of different ages.

2 Caseous or Tuberculous Broncho-Pneumonia
or Caseous Pneumonia

Two types of this condition can be distinguished —

(1) A type in which there are *areas of consolidation scattered through the lung*, spread by the blood or by the lymphatics This type is merely an example of the previous condition where there has been fairly extensive spread into the surrounding lung, so that a considerable group of alveoli have become consolidated and have then undergone the caseous change (Fig 50). This type is found practically exclusively in children The individual areas may fuse with one another, so that the consolidation may be complete, involving a whole lobe Occasionally cavity formation may be found

(2) A type which *commences in one particular portion of the lung*, usually near the apex of the upper lobe, and *spreads from that point* In such a case the infection is generally believed to have been by way of the air passages This type is the common one found in progressive acute tuberculosis in the adult. It is only occasionally seen in the early stages, owing to the fact that it does not prove fatal until well advanced Sometimes, however, the initial stages are met with in cases dying of diabetes or other wasting disease. Usually, as the condition is met with in the post mortem room, the area of consolidation is extensive and cavitation present (Fig 51) Sometimes a less advanced type of the disease is found in one lung when in the other a more advanced stage exists.

Naked eye Appearances—The lung shows *chronic*, occasionally acute, *pleurisy* on the surface It is *partially consolidated*, usually the area of consolidation being *towards the apex* The cut surface shows *areas of a white or slightly yellow, opaque appearance*, not unlike grey hepatisation These may be isolated and scattered, but there is usually one considerable area which may involve the greater part of a lobe In these areas are *cavities*, usually small and often numerous, *with ragged walls* In advance of these areas, and often widely scattered through the lung, are *grey or yellow tubercles in groups*, indicating lymphatic spread (Fig 51) Besides spread by the lymphatics, spread by the bronchi (aspiration) and by direct continuity of tissue in this condition The *bronchi* show evidence of *acute bronchitis* and the *lymph glands* at the root of the lung are *enlarged* and show *grey tubercles* and *caseous foci* There is usually *more or less fibrosis* in connection with this type As the fibrosis predominates, it passes into the next type

This type of the disease has to be differentiated from acute lobar and lobular pneumonia and gangrene of the lung, also from growths of the lung The main points to remember in making this distinction are   1 Position—tuberculous lesions commonly apical   2 Extent—tuberculous lesions as a rule involving only a portion of a lobe   3 Surrounding parts—the presence in the case of tuberculosis of foci of lymph spread disease in the neighbouring portions of lung   4 Cavities—characteristic of tuberculosis, present also in gangrene, but in the latter the cavities possessing soft friable black-coloured margins and the other appearances characteristic of tuberculosis (e g lymphatic spread nodules) being absent.

Microscopic Appearances—The two essential processes going on are (1) a catarrhal consolidation of the lung alveoli which undergoes a caseous change, (2) lymphatic spread of the disease, with formation of caseating tubercles along the lines

of the lymphatics   These tend to spread into surrounding alveoli and bronchi, and so to initiate fresh areas of caseous pneumonia.   The elastic tissue of the lung undergoes a certain amount of destruction, but in the caseous areas the network is preserved and tends to persist until cavitation occurs.   There is usually a certain amount of increase of fibrous tissue as evidenced by thickening of interalveolar walls, interlobular septa, etc.

Cavities may arise (1) in dilated bronchi or bronchioles, (2) as the result of infection of a caseous area with pyogenic organisms, and so the softening of the area   (3) as the result of the bursting of a caseous area into a bronchus.

The cavities are lined with breaking-down, caseous lung tissue.   Suitably stained preparations will demonstrate tubercle bacilli often in very large numbers, both in catarrhal pneumonic areas and in caseous foci or walls of cavities

The vessels are often involved in the process, and blood infection by invasion of a caseous focus into a vessel is not infrequent

3 Fibro-caseous Tuberculosis

This is the common condition found in cases of chronic pulmonary tuberculosis   It passes, on the one hand, by insensible gradations into the previous more acute type of the disease   On the other hand, with increase in the fibrous tissue element, it passes into so-called "fibroid phthisis"   The term is one which is perhaps *not the best possible*, but it is descriptive, and is preferable to the purely clinical one of chronic "phthisis"

The condition is usually complicated by *cavitation*   Hence in speaking of this type one would refer to it as fibro-caseous tuberculosis with cavitation.

Naked-eye Appearances—The lung shows on its surface evidence of *chronic pleurisy*   It is usually *firmly adherent* to the chest wall   For its removal it is advisable to strip the parietal pleura from the ribs in the way described on p. 21   The organ is distended, and on palpation it will be found

partially consolidated Usually this consolidation is *more marked towards the upper part*

On cutting into the lung the increase in consistence will be noted   The section will show the following appearances (Fig 53)   Towards the apex of the upper lobe will usually be found one or more *cavities*, one of which commonly is distinctly larger than the other, varying in size from a walnut to a tangerine orange   Indeed, in some cases the cavity may be found to occupy the whole of the upper lobe   The *walls of the cavity* are formed of *fibrous tissue* and are often comparatively smooth   Frequently bronchi and vessels of considerable size can be seen crossing the cavity, the lung tissue having largely disappeared from around these more resistant structures   Occasionally *aneurysms* may be found on the course of such vessels (Fig 52)

Throughout the remainder of the lung there is a *general increase in the amount of fibrous tissue*   From the thickened pleura, thickened interlobular septa can be seen passing in   The vessels and bronchi are thickened   This thickening is usually more marked towards the root of the lung   The *bronchi* are *not infrequently dilated*   their walls being pulled upon by the contracting tissue around   They show evidence of acute bronchitis and contain more or less muco-purulent secretion

The *bronchial glands* at the root of the lung are *enlarged* and show *caseous* or *calcareous change*

Around the cavity, or cavities, the *lung substance* is *largely consolidated* by a fibro-caseous process   On analysis it will be found to consist of firm nodules, larger and smaller, which are pigmented and show caseous change

In advance of this more completely consolidated area, *i e* in the lower part of the upper lobe and in the lower lobes, will be found *isolated areas of consolidation* of a similar type, having a *staphyloid arrangement* indicating lymphatic spread   In addition, there are often *areas of caseous pneumonia*,

indicating recent acute spread of the disease The presence of the latter area suggests "aspiration" spread.

As a rule, in such chronic cases both lungs are affected, one, usually the right, showing the more advanced lesions

Contraction of the fibrous tissue in the various parts of the lung tends to occur, pulling upon bronchi and air vesicles Dilation is thus caused, producing bronchiectasis or emphysema (*traction emphysema*), as the case may be

The above appearances are found mainly in tuberculosis of adults, but similar changes are occasionally met with in children

This type of the disease requires to be distinguished from the other interstitial pneumonias, more especially from syphilitic disease and from silicosis Again, the distribution of the disease—apical in the case of tuberculosis, at the root of the lung or under the pleura in the case of syphilis—is the chief means of differentiation The presence of cavities is characteristic only of tuberculosis, although it should be remembered that silicosis may be accompanied by tuberculosis. Lastly, the nodules in silicosis are much harder and have a characteristic gritty feel

Microscopic Appearances—One of the most striking changes is the increase of fibrous tissue—thickening of pleura, of inter lobular septa, thickening round vessels and bronchi. The fibrous tissue in these structures often shows a marked new development of elastic tissue fibres. The lung substance itself shows irregular consolidation due to the presence of numerous fibro-caseous areas some of which are nodules of tuberculous granulation tissue displacing the lung tissue Others represent areas of caseous pneumonia, in which the elastic tissue network in suitably stained specimens is still visible, and when surrounded by zones of fibrous tissue. The blood-vessels generally, more particularly those in the neighbourhood of cavities, show thickening of their intima as well as adventitia. Some have, in this way, their lumen completely obliterated. In others the closure is only partial, and new vessels possessing their own elastic laminæ develop within the compass of the

old The bronchi show evidence of catarrhal inflammation, as also the remaining lung alveoli The lining cells of the alveoli are often cubical instead of being flat. The cavities are lined with a zone of granulation tissue or of well formed fibrous tissue The vessels in the neighbourhood become partially or completely occluded by the occurrence of endarteritis obliterans In suitably stained specimens, tubercle bacilli may be found, but they are commonly very few and scattered. They occur chiefly in the walls of the cavities and in areas of caseous pneumonia

Pulmonary Complications in Tuberculosis —Rupture of a cavity into the pleura is not as common as might be expected owing to the adhesions which form, and which tend to obliterate the sac. It occurs chiefly in the more acute cases It may by resting the lung permit of fibrosis and healing of the lesion provided infection of the sac does not occur, but in most instances a pyopneumothorax results

Hæmorrhage from the lung (hæmoptysis) is met with both at an early and a late stage of the disease In the early stage it is seldom serious, as it is due merely to erosion of a small vessel in the wall of a bronchus In the late stage, when large cavities have developed, it is much more serious, as vessels of considerable size may be exposed in cavity walls Sometimes the actual rupture is preceded by a bulging or aneurysm formation

Thrombosis in the larger vessels sometimes occurs, but it is chiefly a terminal phenomenon A thrombus formed in this way in a pulmonary vein may be carried into the systemic circulation and cause embolism in a splenic, kidney, or other terminal vessel

Endarteritis obliterans has already been mentioned as a constant occurrence, one which has a great influence in preventing the more severe forms of hæmorrhage in chronic cases All degrees are met with, from narrowing of the lumen

to complete closure The endothelial lining of the smaller vessels and capillaries is early mobilised in the tuberculous process, forming one source for the epithelioid cell of the follicle This mobilisation leads to obliteration Hence the avascularity of the tubercle nodule

Chronic pleurisy is always met with in chronic tuberculosis It leads, in a majority of instances, to the formation of adhesions and sometimes to obliteration of the pleural sac Usually it is of a fibrous type but an organising fibrinous exudate is not uncommon in acute cases

Fibrosis of the lung substance has been mentioned as a characteristic feature of the more chronic forms of pulmonary tuberculosis rather than a complication The contracting bands of fibrous tissue reduce the size of the lung, diminishing the area of resonance and through adhesions pulling the diaphragm upwards and the mediastinal tissue with the heart in one or other direction The same process tears open the bronchi and the air spaces, producing bronchiectasis and traction emphysema In a large proportion of cases the disease, starting in the apex, progresses only for a short time, ultimately healing and leaving a fibrous scar and a thickened pleura most often situated to the dome of the pleural sac. Occasionally an old healed lesion lights up in later life and spreads rapidly Thus there may be found together lesions of the oldest and the most recent type

Acute pneumonias of a pneumococcic or streptococcic origin frequently terminate tuberculous cases, and acute infections of the pleura occasionally occur, as a rule through rupture of a cavity

Tuberculous infection of the mediastinal and bronchial glands constantly occurs Such glands may show grey infiltration, caseation, or calcification They may rupture into vessels and produce a generalised infection Occasionally a calcareous mass produced in this way ulcerates into a bronchus and may cause hæmorrhage Not infrequently, especially in

children, the disease takes origin in the lymph nodes, subsequently spreading into the lung substances by the lymph channels

Changes in other Organs in Cases of Pulmonary Tuberculosis —In cases of *miliary tuberculosis*, metastatic foci are found in liver, spleen, and kidneys as in the lung Acute degenerative changes, such as cloudy swelling and early fatty change, will be seen in the parenchymatous organs, also acute congestion of the spleen In carrying out post-mortem examinations upon cases of miliary tuberculosis careful search should be made for the site of invasion of the vessel   Attention should be specially directed to the condition of the thoracic duct and the retroperitoneal lymph glands The various branches of the pulmonary artery within the lung should also be slit up

In the more usual form of *caseous pneumonia* or *fibrocaseous tuberculosis*, cloudy swelling and fatty change in such organs as heart, liver, and kidneys is constantly present Not infrequently the liver is greatly enlarged from an extreme degree of fatty infiltration Waxy disease also should be sought in spleen, liver, kidneys, etc   Very often acute metastatic spread of the disease occurs terminally in these cases also, with the presence of miliary foci in all the internal organs   Intestinal tuberculosis—ulceration of bowel and caseous mesenteric glands—is not uncommon as a secondary manifestation due to the swallowing of infected sputum In the more chronic forms of pulmonary tuberculosis the right side of the heart will be found hypertrophied and dilated, and, as a sequel, chronic venous congestion of liver, spleen, etc. Tuberculous meningitis due to spread of the disease to brain or cord is a common termination of the more rapidly progressive cases

Careful investigation should always be made of the various groups of lymphatic glands—cervical, bronchial, mesenteric—

with a view to deciding the point of origin of the disease
The condition of the bones and joints should also be looked
into   Finally, in investigating cases of tuberculosis where
there are many lesions present, with a view to determining
the site of origin of the disease (in other words, the oldest
lesion), the following points should be attended to   (1)
Nature of lesion—caseous foci are always older than grey,
cellular foci, calcareous foci are older than caseous
Fibrosis is also indicative of long standing disease   (2)
Extent of lesion—other things being equal, an extensive
lesion is older than a small one.

Tumours of the Lung—Simple growths of the lung are very
rare   Malignant growths are comparatively common   more
especially sarcomata, but primary growths of a malignant
nature are rare.   Straining as they do the whole of the venous
blood of the body which has not been strained in the capillaries
of the liver, the lungs are apt to be the seat of deposit of
metastatic growths which invade the veins   Thus secondary
growths are common   Sarcomata are much more frequent in
the lungs than carcinomata   The latter occur but in appear
ance they are almost indistinguishable from the sarcomata
Another common type of growth in the lung is a sarcoma
arising in the glands of the mediastinum and spreading into
the lung substance by direct extension (Fig 56)   Occasionally
the growth starts in the pleural surface, and either remains
limited to it or penetrates into the lung

Naked eye Appearances—The growth may occur in the
form of white or grey isolated nodules (Fig 55), or there may
be large areas of lung infiltrated with growth.   In both
instances the condition is not very easily distinguished from
grey hepatisation or tuberculosis, especially as necrosis is
common and spread along the lymphatics of vessels and
bronchi can be seen   In the case of growth, however, the
infiltrated areas have a more translucent appearance, due to
the fact that they are formed of cellular tissue   Another

point of distinction is that cavitation is not observed in growths   Also it should be remembered that the seat of election in tuberculosis is the apex   There is no particular portion of the lung specially liable to be affected by growth unless it be the root.

DISEASES OF THE PLEURA

Hydrothorax or Dropsy of the Pleural Cavity—A slight amount of free fluid is a common finding at a post mortem   Where there is any large quantity, a careful note should be made of the appearance, distribution, and approximate amount of the fluid   It is usually pale, clear, and straw coloured, and has a specific gravity of 1009 1012   On microscopic examination of the centrifugalised deposit, a few endothelial cells and lymphocytes will be found   As a rule the fluid is situated at the most dependent portion of the pleural cavity, but accumulations may occur, limited by adhesions, at other parts   The condition of hydrothorax is found in cases of *chronic heart* and *kidney disease*, where, as a rule, there is dropsy of other parts

Hæmatothorax, or blood in the pleural cavity, is a rare occurrence   Free blood is only found in connection with *injuries to the lung or chest wall* and in *malignant disease* Small extravasations of blood may be found under the visceral pleura in acute infections, in anæmias and in asphyxia.

Pneumothorax i e gas or air in the pleural cavity   This may be due to a *wound of the chest wall or lung rupture of an acute tuberculous cavity*, of healthy lung or emphysematous lung in a paroxysm of coughing   It may also be due to the presence of *gas-producing organisms* in the pleura, these organisms coming usually from a ruptured œsophageal or gastric ulcer, or spreading through the diaphragm from a liver abscess or peritonitis   In the last case a purulent inflammation of the cavity is present as well, the condition being known as *pyopneumothorax*

In all the above conditions, in the absence of adhesions which would bind the lung to the chest wall, complete collapse of the lung occurs

Acute Pleurisy—This condition may be *primary*, due to spread by blood or lymph, or *secondary*, due to extension from lung, pericardium, mediastinum, peritoneum, etc Three types of the condition may be distinguished—

(1) *Dry* or *fibrinous*, where there is little or no free fluid

(2) *Serous* or *sero-fibrinous* where there is more or less free fluid, in which there are commonly flakes of fibrin floating

(3) *Purulent*, where there is purulent fluid

The last is usually known as empyema.

Naked eye Appearances—The surface of the lung shows, over a larger or smaller area, a *rough granular* or *thick opaque white* or *yellow deposit* (Fig 54) This may be adherent or easily removed according to the duration of the inflammatory process The pleura underneath shows injection of its vessels and the subjacent lung may show pneumonic consolidation, or sometimes abscess formation If the fluid be large in amount and if there are no adhesions binding the lung the organ shows collapse

In the case of empyemas which have been in existence for some time, there is usually considerable thickening of both parietal and visceral pleura (Fig 41)

Microscopic Appearances—The vessels of the pleura are distended with blood. There is a fibrinous coagulum on the surface, and also in the interstices of the pleura, in the meshes of which are entangled leucocytes, chiefly of the polymorphonuclear variety in the earlier stages. The endothelial cells of the pleural surface may be swollen but still attached, or they may be thrown off and occur free amongst the fibrin. If the condition has lasted for some time, there is evidence of organisation—young blood vessels budding out from the pre-existing ones of the pleura, and young connective tissue cells accompanying these into the exudate. These latter (fibroblasts)

are at first rounded, and possess a relatively large amount of
protoplasm Later they tend to become spindle shaped, and
eventually to arrange themselves parallel to the pleural surface
From their protoplasm, fibres are split off which form the
intercellular fibres of the new tissue

Empyema.—Although the word is also applied to purulent
conditions of the gall bladder and other closed spaces, the
usual significance of the term empyema is a collection of pus
in the pleural sac As regards content, there are all grada-
tions between an ordinary pleurisy with clear serous fluid
through sero purulent exudate to thick opaque pus The
condition may be generalised, *i e* the inflammatory process
may extend throughout the sac, or it may be limited by
adhesions Occasionally the pus, limited in this way, collects
between the diaphragm and the lung, or between two lobes
of the lung or between the lung and the pericardial sac
Such accumulations may discharge themselves by opening
into the lung In that case they may be classed as pul
monary abscesses The condition most frequently follows a
pneumonia, and the commonest germ is the pneumococcus
Another very common organism is a streptococcus, others
occasionally met with are staphylococci, *B pyocyaneus*, and
germs of intestinal origin Sources of infection other than
the lung are the blood in pyæmia, a penetrating missile or
instrument such as an exploring needle, a focus of suppura
tion in the peritoneal cavity or liver, and an ulcerative con
dition of the œsophagus The pleura is usually thickened,
in the chronic cases greatly so, and shows microscopically
the appearances of an organising pleurisy Should the
exudate remain unabsorbed or unevacuated, calcareous
material may be deposited in it

Collapse of the lung to a greater or less extent is of course
a constant occurrence in diffuse empyemas Re-expansion
occurs subsequent to absorption or evacuation of the exudate
unless the case be very chronic and the lung bound down by
firm adhesions

If gas, either from the lung or from the presence of gas producing germs, occurs in the sac along with the exudate, the term pyopneumothorax is applied

Chronic Pleurisy—This is a very common condition, either in the form of adhesions between lung and chest wall, or as areas of thickened pleura without adhesions. It is a constant occurrence in subacute or chronic disease of the lung, such as tuberculosis. In this disease the pleura may be very greatly thickened, as much as one inch in certain cases.

Microscopic Appearances—The thickened pleura consists of spindle-shaped connective tissue cells arranged parallel to the surface with intervening sinuous collagenous fibres. Some times these latter are separated more or less widely from one another owing to œdema. Through this tissue are scattered a few wandering (lymphocyte like) cells. Running at right angles to the surface of the original pleura are vessels which vary in size and thickness.

METHOD OF EXAMINING A LUNG REMOVED FROM THE BODY

Look in the first place at the shape of the organ. The normal lung will become flattened on being placed upon a table, *whereas the consolidated lung* (whether the consolidation be due to fluid or solid exudate in the alveoli) retains its rounded shape. Note the size of the organ An organ the seat of emphysema is usually more voluminous than usual. Weigh the lung The weight of the normal lung is about 1 lb 3 oz. to 1 lb. 12 oz. (538-764 grammes), the right being a little heavier than the left, and the lung of the male somewhat heavier than that of the female. Examine the surface of the organ for exudate, fibrous thickening, small hæmorrhages Note the amount of pigment present at the points where the interlobular septa join the pleura. Examine the margin for evidence of emphysema and look for any puckering of the surface, especially at the apex Next feel the organ carefully all over, searching specially for any hard areas which would indicate consolidation. Note the distribution of the firm areas, whether discrete or diffuse. Incise the organ longitudinally

(see p 29) and examine the cut surface as to colour   Note
the distribution of any congested areas   Feel the surface
carefully and squeeze the tissue between the fingers, noting if
any fluid escapes and the character of such fluid.   Any areas
of consolidation should now receive more careful attention as
regards colour, distribution, etc.   It may be necessary further
to incise firm nodules or areas and to remove portions in order
to ascertain whether they sink or float in water   Where cavities
are present their position, shape, character of contents, wall,
and surroundings are all points to note   The large bronchi
should then be opened and the character of their contents and
appearances of their walls noted   The bronchial and medi
astinal glands should be examined as to size, consistence,
presence of grey or yellow tubercles etc.   The branches of
the pulmonary artery should be slit up and examined for
impacted thrombi.

CHAPTER VIII

DISEASES OF THE INTESTINAL TRACT AND PERITONEUM

Diseases of Mouth, Pharynx, etc. — The *condition of the teeth* should always be investigated. The presence of caries should be noted. More particularly in cases of severe anæmia, *suppuration* should be looked for *in the mouth cavity*. Pyorrhœa alveolaris is commonly associated with chronic toxæmia and anæmia. In any case where *enlargement of the cervical glands* is present, the mouth and pharynx should be carefully investigated for tumour formation, suppurative foci, actinomycosis, etc.

In *diphtheria* the tonsils and pharynx should be examined for false membrane. It appears as grey opaque areas surrounded with congestion. The membrane in this position is not easily removed, as it is formed of the covering epithelium infiltrated with fibrinous exudate. In any suspicious case not diagnosed during life, cultures on blood serum as well as films should be made.

Acute Pharyngitis. — Acute catarrh of the pharynx is a constant accompaniment of the common cold. It may spread upwards into the nose and its sinuses or downwards into the larynx, trachea, bronchi, and lungs. A certain proportion of pneumonias start as sore throats. Another important extension is up the Eustachian tube and into the middle ear, where an acute otitis media may be set up with suppuration, rupture of the ear drum, possibly extension to

the mastoid antrum, and complications in lateral sinus and brain Whether or not there is a specific germ for the con dition is uncertain, but pneumococci and streptococci are the organisms which most often grow on culture, and they are usually present in the complications of the accessory sinuses and middle ear Repeated attacks of catarrh are often associated with the abnormal development of lymphadenoid tissue in the region—adenoids and enlarged tonsils

Acute pharyngitis is also a manifestation or *complication of many of the specific fevers*, notably of scarlet fever, diphtheria, and influenza The throat is acutely congested and swollen, and there is a tendency for the accumulation of secretion, which in the case of diphtheria forms what is known as a false membrane Streptococci are almost constantly present in these infections either alone or accompanying other germs There is a marked tendency for the infection to spread to the neighbouring lymph glands, and sometimes a spreading inflammation of the tissues of the neck (angina) results In such a condition œdema of the glottis may occur

Tonsillitis —Acute inflammation of the tonsil is a constant accompaniment of acute pharyngitis or sore throat Repeated attacks of the condition lead to an enlargement which is more or less permanent, and which is a simple lymphoid hyperplasia (enlarged tonsil) Sometimes foci of suppuration develop and may remain unrecognised and form areas of absorption of bacteria and their products Streptococci are the common germs present At other times a large abscess (quinsy) develops rapidly and may discharge of its own accord

What is known as *epidemic sore throat* or *glandular fever* is an infection due to streptococcus hæmolyticus, conveyed, it is most generally believed, from the cow's udder, by milk or milk products There is marked cervical glandular enlargement, which usually subsides but may end in suppuration

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Acute rheumatism is another condition almost certainly due to a streptococcus which very commonly starts in this situation. The organism enters the blood from the tonsils and shows a marked tendency to attack the joints and the endocardium, setting up an acute non suppurative arthritis and vegetative endocarditis. There appears to be a group of allied organisms, all streptococci, which specially affect the tonsillar region and show the same affinity for joints and for the endocardium.

Diphtheria has been referred to as usually starting in this region, often on the tonsil itself. It is characterised by the formation of a grey false membrane partly made of fibrinous exudate, partly of dead surface epithelium, and therefore difficult to remove. Unlike some of the other affections of this region the germ does not commonly enter the lymph or blood stream although complicating germs such as streptococci may do so. On the other hand, the toxin of the organism is readily absorbed and shows a special affinity for nervous tissue.

A condition common on the tonsil and not infrequently mistaken for diphtheria is Vincent's angina. It is due to the presence of two germs—a spirochæte and B fusiformis. There is often a membrane present which in contrast to diphtheria, is easily removable. Ulceration may occur in chronic cases.

Syphilis and tuberculosis both attack the tonsillar region. In secondary syphilis, erythema and mucous patches occur, the latter sometimes simulating diphtheria and Vincent's angina.

The tonsil is generally regarded as an important portal of entrance in tuberculosis. The disease may pass through into the lymphatic system without producing any change other than simple enlargement. Thus a proportion of tonsils excised for enlargement are found to show on careful micro-

scopic examination evidence of active tuberculosis   A
certain percentage of these tuberculous infections are bovine
in origin   The cervical glands become infected and the
disease may spread from there to various parts of the body

Diseases of the Œsophagus — When any condition
affecting the œsophagus is suspected, as in poisoning, dys
phagia, hæmatemesis, care should be taken to remove the
viscus entire along with the pharynx and stomach   This
can best be done by removing tongue, pharynx, contents
of chest and abdomen in one piece as described on p 24,
and then removing the individual organs as required, opening
the œsophagus from behind and examining it in continuity
with the stomach

The œsophagus is not infrequently the seat of *varicose
veins in cirrhosis of the liver*   This is due to the fact that the
veins from the lower part of the œsophagus drain indirectly
into the portal vein, which in cirrhosis of the liver is obstructed
The œsophageal veins dilate and become varicose   Such
veins may rupture, and severe, even fatal, hæmorrhage result

The œsophagus suffers along with the stomach in *corrosive
poisoning*, and presents much the same appearance as that
organ (see p 394)   Rarely it may be the seat of *peptic ulcer* in
its lower part   Such an ulcer may rupture into one or other
pleural cavity and cause a pyopneumothorax

Tumours of the œsophagus are occasionally found, by far
the most common being squamous epitheliomata   Very infre
quently leio myomata are seen   The squamous epithelioma
of the œsophagus is found in the form of an ulcer with
raised infiltrating margin   It tends to form a ring shaped
area of constriction, and is situated either high up about the
level of the cricoid cartilage, low down near the cardiac orifice
of the stomach, or at the level of the bifurcation of the trachea
(Fig 57)   The ulcer may extend deeply, perforating the
trachea, bronchi, one or other pleural cavity, or pericardial sac.

DISEASES OF THE STOMACH

Owing to the action of the digestive juices of the organ itself, and owing to decomposition in its contents and in the contents of the neighbouring viscera, the stomach undergoes considerable changes after death, and the longer the sectio is delayed the greater will be those changes Blood tends to accumulate in the vessels of the organ at its more dependent parts, giving the appearance of congestion, and even of hæmorrhage As the result of decomposition in this blood green discoloration takes place Frequently there is softening of the wall owing to digestion by the gastric juice This may occur to the extent of causing actual perforation Obviously, therefore, care must be taken in interpreting changes found in the stomach *post mortem* Changes such as softening when they occur before death tend to be diffuse in their distribution, whereas post mortem softening is found mainly in the more dependent, and therefore posterior, part of the viscus.

Foreign bodies of various kinds may be found in the stomach, such as false teeth bundles of hair or thread, or undissolved medicinal tabloids in cases of suicide

Dilatation of the Stomach. — Gastrectasis. — *Acute dilatation* may be due to the ingestion of excessively large quantities of food, or it may be nervous in origin sometimes following surgical operations

Chronic dilatation may be due to (1) narrowing of the pylorus from tumour, (2) the presence of abnormal contents from fermentation and atony of the muscular wall associated with chronic catarrh.

Contractions of the Stomach. — Narrowing of the pyloric orifice (*congenital pyloric stenosis*) through thickening of the muscular coat is a somewhat rare condition Localised contraction of the organ may occur as a sequel to

ulceration   It tends to produce the condition of " hour glass " stomach

Chronic Venous Congestion. — In chronic valvular disease of the heart, chronic lung and liver disease, passive hyperæmia tends to occur in the stomach as in other organs It is usually associated with the appearances of chronic catarrh, accompanied by congestion of the vessels of the mucous membrane   Minute hæmorrhages may occur, and these may be followed by small superficial ulcerations (*hæmorrhagic erosions*)

Acute Catarrh of the Stomach may occur as the result of (1) dietetic errors , (2) the ingestion of irritant or corrosive poisons , (3) in the course of infective fevers

Naked eye Appearances —In slight cases there may be little or no alteration   In severe cases the walls of the viscus are swollen, the mucous membrane congested, and covered with strings of sticky mucus   Small hæmorrhages may occur   Where the cause has been one of the corrosive poisons there may be necrosis and sloughing of the mucous membrane, sometimes with perforation   In the case of certain poisons characteristic colouring may be present   For further information on the appearances of the stomach in cases of poisoning see pp 393 95

Microscopically the vessels of the wall are d lated   There is shedding of the superficial epithelium, and, in the more severe varieties necrosis   The wall is infiltrated with inflammatory cells and exudate from the vessels

Acute Suppurative Gastritis sometimes occurs in the course of specific fevers and pyæmia or as the result of spread of inflammation from neighbouring parts   The portion of the wall affected is thickened pale yellow in colour, and found, on microscopic examination, to be infiltrated with fibrin and leucocytes   The mucous membrane superficial to the area shows acute catarrh, and sometimes exudate

Chronic Catarrh.—This may follow acute catarrh or develop independently It is frequent in chronic alcoholics, and occurs in association with chronic venous congestion, peptic ulcer, and carcinoma

The stomach is usually dilated The mucous membrane is pale and atrophied There may be scattered small hæmorrhages or pigmented black areas following such The surface of the mucous membrane is covered with thick sticky mucous secretion Small follicular ulcers may be present These ulcers are shallow with undermined edges They may heal, leaving a small puckered scar

Microscopically beyond some overgrowth of fibrous tissue, catarrh of the gland cells, and infiltration of the coats with round cells, there is little to be seen.

Peptic, Perforating, or Chronic Ulcer—This condition is found more frequently in females than in males It is chiefly found in young, anæmic girls between the ages of twenty and thirty It may be associated with chronic gastric catarrh

The ulcer is commonly single, but occasionally there is more than one It is *situated* usually on the posterior wall near the lesser curvature, and nearer the pylorus than the cardia. About 1 per cent occur on the anterior wall The ulcer varies in *size* Usually it is about the size of a sixpence, but it may be much larger The *margins* of the ulcer are rounded, smooth, and devoid of evidence of inflammation, presenting a punched-out appearance (Fig 58) The *floor* may be formed by one of the coats of the stomach, but not infrequently it is formed of fibrous tissue, or of one or more of the organs behind the stomach, such as pancreas or liver

Owing to the fact that the opening in the mucous membrane is larger, the opening in the muscular coat smaller, the ulcer may show a terraced appearance The associated chronic inflammation in the wall of the viscus causes the formation of adhesions to structures lying posterior, hence with increase

of depth these organs become exposed in the floor of the ulcer Not infrequently, however, before such adhesions can form *perforation* occurs In the case of the ulcer on the posterior wall this will take place into the lesser sac of the peritoneum The acute peritonitis resulting is thus, at first, limited In the case of the anterior ulcer, perforation occurs more rapidly, and takes place directly into the peritoneal cavity, causing a general peritonitis *Healing may* take place, associated with cicatrisation and sometimes the forma tion of an " hour glass " stomach Besides perforation, another accident which may occur is *hæmorrhage* due to erosion of a vessel in the wall of the stomach, or possibly one of the larger vessels lying behind the organ

A similar type of ulcer is sometimes found in the *duodenum* immediately beyond the pylorus It resembles the peptic ulcer of the stomach in every respect except that it is more frequent in the male sex As a rule the ulcer is small, but it may attain a large size (Fig 59) As in the case of the stomach ulcer, the floor may be formed by fibrous tissue or by an organ such as the pancreas Perforation and hæmorrhage are accidents not infrequently met with in this case also

The causation of both types of ulcer is obscure Throm bosis occurring in a vessel supplying the mucous membrane, with consequent malnutrition and then digestion by the juices within, has been suggested as an explanation of their occurrence

Fibromatosis —Occasionally the stomach is the seat of a diffuse fibrous overgrowth implicating chiefly the sub-mucous and muscular coats and commonly associated with a chronic ulcer This condition, which is usually most marked at the pyloric end of the organ has been called *fibromatosis* It is sometimes mistaken for malignant new growth

Tumours —*Simple tumours* of the stomach are rare

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The causation of both types of ulcer is obscure Thrombosis occurring in a vessel supplying the mucous membrane, with consequent malnutrition and then digestion by the juices within, has been suggested as an explanation of their occurrence

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Tumours—*Simple tumours* of the stomach are rare

Fibromata, myomata, adenomata are described   *Mucous papillomata* also occur

Of malignant tumours, sarcomata are uncommon.

Carcinoma —This is the common stomach tumour   It is most frequently situated at the pyloric end (60 per cent) The next most frequent site is the lesser curvature (20 per cent)   About 10 per cent occur at the cardiac orifice (Fig 60) As regards the type of cancer found, the most common is the encephaloid variety of the adeno-carcinoma.   The next most common is the scirrhous, then the colloid, and least frequent is the squamous epithelioma, which is occasionally found at the cardiac end

The tumour may lead to a localised or diffuse thickening of the stomach wall   More frequently there is an ulcerated surface with a raised, hard, infiltrated margin   Sometimes the growth projects into the interior of the viscus as a cauliflower like mass (Fig 60)   The floor is formed of necrosed tumour substance   Perforation rarely occurs   Secondary deposits are very commonly found in the neighbouring glands and in the liver

DISEASES OF THE INTESTINE

Post-Mortem Changes.—These, as in the case of the stomach, tend to come on rapidly and are often very pronounced in cases when the autopsy is delayed or when the body is not kept under cool conditions   The coils of in testine become distended with gas   The gut wall assumes a dusky red colour from hæmoglobin staining   This is most marked in the more dependent coils   Softening of the mucous membrane and sometimes escape of blood occur Digestion of the upper portion of the bowel may take place, but this does not as in the case of the stomach lead to actual rupture.   If blood pigment is present either in the wall or

intestinal contents it rapidly assumes a black colouration owing to the formation of sulphide of iron

Malformations.—Meckel's diverticulum is a finger like *cul de-sac*, the remains of the omphalo mesenteric duct, usually 2 3 inches in length, occurring some 2 or 3 feet above the ileo-cæcal valve It is sometimes attached to the umbilicus It may become closed and give rise to cyst or abscess formation, or it may become adherent to the parietes, thus forming a band under which a loop of bowel may become strangulated

Smaller diverticula may be found in connection with other parts of the small intestine, such as the duodenum, and pouches between the layers of the mesentery may be found Similar diverticula occur in the large intestine, and may when filled with inspissated fæcal matter be mistaken clinically for tumours

Dilatation of the bowel is found as the result of peritonitis (paralytic distention), constipation, obstruction from strangulation, infarction or tumour formation When the obstruction is long-continued the wall of the bowel above shows hypertrophy (Fig 69)

A condition of dilatation of the large intestine, more especially of the ascending colon, associated with hypertrophy of the muscular coat, known as *Hirschsprung's disease*, occasionally occurs It is believed to be congenital

Stenosis, or narrowing of the bowel, may be due to contraction associated with ulceration (especially tuberculous), tumour formation, or chronic peritonitis

Volvulus is a condition in which the bowel is obstructed by a loop of intestine becoming twisted upon itself Half the cases occur in the pelvic colon An abnormally long mesentery

predisposes to its occurrence.   The blood supply of the portion of gut is interfered with and gangrene tends to occur

Intussusception is a condition in which a portion of the bowel is invaginated into the section immediately below It occurs chiefly in infants, and is believed to be caused by violent peristalsis due to active purgation or diarrhœa   The condition may occur in the ileum or the colon, or at the ileo-cæcal valve   The portion of bowel involved forms a sausage shaped tumour (Fig. 61)   Pressure on the mesentery of the intussuscepted portion causes interference with its circulation and a tendency to gangrene

A similar condition easily reduced and often multiple, is not infrequently found *post mortem*   It is believed to develop very shortly before death   In this type there is, of course, no congestion of the intussuscepted portion, and there are no adhesions between the various layers of gut.

Hernia.—A hernia is usually defined as a condition in which there is a protrusion of any of the abdominal contents from the cavity of the abdomen   The term is also used in connection with the rare occurrence of a protrusion of gut through an opening such as the foramen of Winslow, within the abdomen.

As a rule it is either a *portion of bowel* or a *portion of omentum*, or both, which protrudes   Occasionally it may be a Meckel's diverticulum or an organ such as liver, spleen, or stomach.   The *sac* of the hernia is usually lined by peritoneum, although this may disappear

The condition may be *congenital*, the sac being formed by a diverticulum of the peritoneum such as the processus vaginalis   More usually it is *acquired* through increased abdominal pressure from coughing, crying, straining, or through weakness of the abdominal wall, or from these two factors combined It may also be due to violence, such as a crush driving some of the abdominal contents through the diaphragm

The protrusions are found *at points of weakness* in the abdominal wall, usually where vessels enter and leave   The commonest type is the *inguinal hernia* which occurs in the inguinal canal and may be congenital or acquired   The second commonest type is the *femoral hernia*, a projection through the femoral ring   In addition, there is an *umbilical* type found at the umbilicus which may be congenital or acquired   The latter type is found chiefly in very fat women   Certain rarer forms are occasionally met with, such as *obturator hernia*, also herniæ through the abdominal wall at points which have been weakened by scars following operations

The condition is not of much importance to the morbid anatomist.   Herniæ are not infrequently met with by accident at a post mortem   Strangulation of the hernia, *i e* interference with the circulation of blood through the gut with consequent acute congestion and sometimes gangrene, is a cause of acute peritonitis but it is rarely seen post mortem   Internal herniæ, *e g* herniæ through the diaphragm, are sometimes met with as the result of severe crushing of the abdomen

Chronic Venous Congestion of the bowel is found in cirrhosis of the liver and in chronic heart and lung disease   There is swelling and congestion of the wall of the gut, especially of the mucous membrane   A degree of catarrhal inflammation is very constantly associated

Infarction of a portion of bowel, most frequently of that part supplied by the superior mesenteric artery, is sometimes found   It should be looked for in cases which die with symptoms of intestinal obstruction   The portion of gut involved is deep purple in colour, and usually shows peritonitis on its surface   The aorta and its branches should be slit up to find the point where the block occurred   Careful search should be made for a possible source of the embolus,

e.g. a thrombus on an atheromatous patch of the aorta, or in the left side of the heart (see diag p 66) Acute aneurysms, sometimes as large as a pigeon s egg may form at the site of the embolism

Hæmorrhage occurs into the mucous membrane of the bowel in the form of small extravasations in cases of infective diseases, anæmias, etc

Large hæmorrhages may occur from ulcerated surfaces, such as duodenal or typhoid ulcers The blood, mixed with fæcal matter, tends to undergo alteration into a black mass of putty like consistence which can be seen through the wall of the gut before it is opened

INFLAMMATION OF THE SMALL INTESTINE— ENTERITIS

Acute Catarrhal Enteritis may be caused by irritating foods, poisons, dust, by normal bacterial inhabitants of the bowel, such as *B coli* or *streptococci*, or by specific bacteria such as *B typhosus* and *Vib choleræ*

Naked eye Appearances —These are often unsatisfactory The clinical symptoms are frequently out of all proportion to the pathological findings Usually there is some congestion of the vessels of the mucous membrane, which is more or less swollen This congestion may be diffuse or patchy Often it is most marked at the apices of the folds in the mucous membrane When due to the action of a micro-organism the changes are commonly more marked in the lower part of the ileum. In cases of poisoning, on the other hand, the duodenum and upper part of the jejunum in addition to the stomach are the parts most affected, although it must be noted that irritant poisoning often causes little change (see p 395) Not infrequently the lymph follicles of

the bowel are swollen (*follicular enteritis*) and may ulcerate (*follicular ulcers*) The mucous membrane may be covered with viscid mucus Sometimes there is a distinct membrane formed of exudate (*membranous enteritis*) Occasionally, in the more intense forms, the mucous membrane may undergo necrosis, forming a greenish slough Small embolic abscesses may be found in pyæmia or there may be a general infiltration of the wall of the gut with pus (*suppurative enteritis*)

Microscopic Appearances —There is dilatation of the vessels of the bowel, infiltration of the wall with inflammatory cells and exudate, increase of the lymphoid elements and swelling of the endothelial cells in the solitary glands, catarrh of the superficial epithelium. In suppurative enteritis small abscesses and more intense inflammatory infiltration are found

SPECIAL FORMS OF ENTERITIS

1. Cholera.—The changes are most marked in the lower portion of the ileum There is intense swelling and congestion of the mucous membrane The lymphoid follicles may be swollen and pale Small hæmorrhages may be present Membranous enteritis may occur, due to the exudation of fibrin on the surface of the mucous membrane The contents of the bowel are pale and watery (rice water)

Microscopically, there is marked catarrh of the epithelium, possibly exudate on the mucous membrane, and infiltration of the wall of the bowel with inflammatory cells The specific organisms do not penetrate the wall for any distance, but they are found in immense numbers along with desquamated epithelial cells in the rice water contents of the bowel. At a post mortem on a case of cholera, extreme rigor mortis is present. The blood is very dark and the muscles and tissues generally dry Little that is characteristic is found in the internal organs. Small hæmorrhages are sometimes seen in

the pericardium and endocardium   The mesenteric glands are
commonly enlarged and show areas of necrosis.   As in typhoid
the bile offers a special attraction to the causal germ   Thus
cholera carriers may develop in the same way as typhoid
carriers

2 **Typhoid.**—In this condition also the change is *most
marked in the lowest portion of the ileum*   It consists, in the
early stage, in a *swelling* of the lymphoid tissue generally,
both Peyer's patches and solitary follicles (Fig 62)   These
areas are pale, but the bowel between may show congestion
At about the beginning of the second week of the disease,
necrosis commences in these swollen accumulations of lymph
oid tissue (Fig 63)   In this way *sloughs* form which take
on a yellow or green colour from bile staining   These *sloughs
separate* towards the end of the third week of the disease and
ulcers are left which have the following characters —The
larger ones, representing as they do an ulcerated Peyer's
patch, are usually in the longitudinal direction of the bowel,
during the separation of the sloughs *hæmorrhage* tends to
occur   The smaller ones, representing the solitary follicles,
are rounded   The *edges* of the ulcers are ragged and over
hanging   The *floor* is formed of one of the coats of the bowel
—the submucous, muscular, or peritoneal   Perforation is not
infrequent   The *peritoneal aspect* of the portion of bowel
may show evidence of acute inflammation by injection of
vessels and even fibrinous exudate

Occasionally, in cases dying from complications late in
the disease, the ulcers may be found in process of *cicatrisa
tion*

In a case of typhoid fever, in addition to the condition
of the intestine, attention should be paid to (1) the mesenteric
glands, which are constantly enlarged, congested, and may
show hæmorrhages and necrotic foci , (2) the spleen, which
shows acute congestion, and, microscopically, areas of focal

affecting stomach, small intestine, and large bowel, char acterised clinically by symptoms not unlike cholera, and showing congestion of the mucosa, acute catarrh, and cell in filtration (b) A type resembling ordinary typhoid clinically On the rare occasions when such cases come to autopsy, lesions of the small intestine, glands, and spleen may be found similar to those seen in typhoid On the other hand, no characteristic lesion of the bowel may be present.

3 **Tuberculosis** —This is usually secondary to tuber culosis of the lungs, the intestine becoming infected by the swallowing of sputum containing tubercle bacilli As a primary condition of the bowel, the disease is comparatively rare, although it has been found in as large a proportion as 12 per cent of all cases of tuberculosis.

Tuberculosis of the mucous membrane of the bowel is, however, by no means necessarily found in cases where the intestine is the path of entrance of the tubercle bacillus The disease may show itself first in the mesenteric glands or in the peritoneum, no demonstrable lesion of the bowel itself being present

Naked eye Appearances —The part commonly affected is, as in typhoid, the lower portion of the ileum The earliest lesion consists in a tubercle nodule underneath the mucous membrane Ulceration occurs over this, and tends, owing to the distribution of the lymphatics of the bowel, to spread laterally, often encircling the bowel, with the exception of that portion over the attachment of the mesentery The appear ances in the fully developed ulcer are as follows (Fig 64) the *direction* is transverse to that of the bowel, although this character is by no means constant, the *edge* is irregular, nodular, but rounded, the *floor* is formed of tuberculous granulation tissue, the *peritoneal aspect* shows opaque white thickening of the wall, the presence of tubercle nodules (Fig 65) under the peritoneum, and sometimes white lines of

injected lymphatics radiating from the area   Constriction of the bowel is common, as also is adhesion to surroundings.

Perforation is a comparatively rare occurrence in tuberculous ulceration, as also is hæmorrhage.

The mesenteric glands are constantly enlarged and show caseous areas or grey granulations, occasionally calcification.

Microscopic Appearances —At the margins of the ulcer, in the floor, often replacing the muscle substance, and under the peritoneal coat, there are tubercle granulations with giant-cell or caseous centres   Tubercle bacilli are not, as a rule, numerous

TUBERCULOSIS AND TYPHOID ULCERS CONTRASTED AS REGARDS THEIR NAKED EYE APPEARANCES

	Tuberculous Ulcer	Typhoid Ulcer
Direction	Typically transverse.	Typically longitudinal.
Margin .	Raised, rounded, nodular	Overhanging, ragged.
Floor . .	Irregular, formed of tuber culous granulation tissue	Smooth, formed of one of the coats of the bowel
Peritoneal aspect	Raised, grey or yellow tubercles. Thickening and sometimes constric tion. Perforation rare Adhesions frequent	Evidence of acute inflam mation, congestion, exu date Perforation fre quent. No adhesions or constriction
Associated mesenteric glands	Enlarged and firm, caseous. Sometimes calcareous.	Enlarged, congested with necrotic foci, soft.

4. **Syphilis.**—This is a rare condition   It may occur in the form of *gummata*, *ulceration*, or *cicatrisation with stenosis.*

5 **Actinomycosis.**—This is also rare.   It may affect the intestine or appendix.   Secondary abscesses usually occur in the liver.

14

INFLAMMATION OF THE LARGE INTESTINE

In its slighter forms this condition is known as *colitis*, in its more severe forms as *ulcerative colitis* or *dysentery*

As regards *causation*, (1) the slighter forms of the disease may be due to indiscretions of diet, chill, germs of various kinds   Of the more severe types, two varieties are distinguished   (2) *Bacterial Dysentery*, with which organisms closely related to B coli, e g Shiga's bacillus and Flexner's bacillus, are more especially associated, (3) *Tropical Dysentery*, generally believed to be caused by a protozoon, the *Entamœba histolytica*

(1) The milder types of inflammation show congestion of the mucous membrane, some œdema, swelling of the lymphoid follicles, and, sometimes, slight superficial ulceration

Microscopically, beyond catarrh of the mucous membrane, congestion of vessels, and infiltration of the coats with inflammatory cells, there is little to be seen

(2) *Ulcerative Colitis or Bacterial Dysentery* —The wall of the bowel is usually thickened   On opening the gut there is irregular ulceration with tags of thickened mucous membrane between the ulcers (Fig 66)   These tags often occur in longitudinal ridges   The edges of the ulcers are overhanging, and the floor is usually formed by the submucous or muscular coat Occasionally, destruction of the muscular coat is found, and sometimes perforation

Microscopic Appearances.—There is catarrh of the mucous membrane and thickening of the submucous and muscular coats   These are infiltrated with inflammatory cells and exudate, and there is marked swelling of the endothelial cells of the lymphatics and vessels

The above description holds good more especially for the type of the disease found in Great Britain   In the type

found in Japan, hæmorrhages into the mucous membrane, purulent and fibrinous exudates on to the surface of the mucous membrane are described in addition to ulceration

(3) Tropical or Amœbic Dysentery —The wall of the bowel is thickened, due largely to a thickening of the submucous coat, partly from fibrous change, partly from inflammatory infiltration Scattered through the mucous membrane are numerous small raised nodules the size of pin heads or small peas, most of which show a small opening in the mucous membrane through which a whitish slough can be seen (Fig 67) The bowel between is congested These minute ulcers tend to run together, forming areas of more extensive ulceration In the case of the larger ulcers the edges are overhanging and the floor is formed of submucous or muscular coat Rarely perforation of the bowel may occur

The seat of the more intense changes varies in different cases Sometimes it is the cæcum and ascending colon, sometimes the transverse, sometimes the descending or pelvic colon

The condition is very commonly associated with the tropical form of liver abscess

Microscopic Appearances — The wall of the bowel is thickened, more especially the submucous coat It is also infiltrated with inflammatory exudate and cells The nodules above mentioned are found to be flask shaped ulcers in the submucous coat, with overhanging margins and a small opening into the lumen of the bowel The centre is occupied with a slough consisting of necrotic tissue and leucocytes Amœbæ are found in the slough and in the submucous coat around They appear as large rounded cells with vacuolated protoplasm and a relatively small round nucleus. They can be seen in specimens stained with hæmatin and eosin, but are better demonstrated by eosin, methylene blue (p 424) In the areas of more extensive ulceration the ulcers lose their characteristic appearance, and the changes are more like those found in the other type of dysentery

Pseudomembranous or Diphtheritic Colitis — This is a term applied to a form of dysentery due to bacterial invasion, often by streptococci, also to ingestion of mercuric chloride Occasionally it is seen as a terminal condition in nephritis Any part of the large bowel, sometimes the whole length, may be affected The mucous membrane is intensely congested and swollen and the superficial layer shows necrosis Patches of fibrinous exudate also occur Thus a "false membrane" is formed which often appears black when examined after death. If the patient survives for some time the necrosed tissue sloughs away, leaving ulcers which vary in size, shape, and depth

Mucous Colitis — This is a condition in which tubular casts of the bowel or strings and masses of clear mucus are evacuated from time to time The casts consist of inspissated mucus due to hypersecretion The condition is frequently of nervous origin aggravated by growth of bacteria and is accompanied by dilatation of the large intestine

Appendicitis — The appendix is a *cul-de-sac* in continuity with the cæcum having the structure of the large bowel, with a large development of lymphoid tissue in its submucous coat, hence the name sometimes given to it of intestinal tonsil It is subject to inflammatory changes spreading from the large bowel such as typhoid and the various forms of colitis, as well as to changes originating in the organ itself Foreign bodies such as particles of metal and vegetable seeds, animal parasites such as *Oxyuris vermicularis* and fæcal matter may lodge in its lumen Much of this material it is able to extrude by its muscular contractions Fæcal material is constantly entering and leaving it along with its own secretions Sometimes it remains for long periods and becomes inspissated and impacted In addition *concretions* tend to form which differ from inspissated fæces in being rounded and consisting of undigested particles of food glued together by mucus and having calcareous material deposited in them None of these foreign bodies play an important part in the causation of acute appendicitis They may obstruct and cause the accumulation

of secretion distal to their point of impaction They may harbour germs and they may give rise to irregular contractions and thus to pain, but they do not cause appendicitis

The actual cause of the condition is a germ—usually, in the first instance, according to Aschoff, a diplo- or strepto coccus Whether this enters from some outside source or is a normal inhabitant of the bowel with its virulence tem porarily raised is doubtful In the later stages, when the inflammatory process is established, other germs such as *B coli*, *B proteus*, *B lactis aerogenes*, various anaerobes and other organisms are found Occasionally *B tuberculosis* and *Streptothrix actinomyces* occur as the main pathogenic agent

The primary lesion, in Aschoff s opinion, is to be found in a small epithelial defect in one of the bays or indentations of the mucous membrane Sometimes the infective agent arrives by the blood stream, the germs depositing themselves directly in the submucous coat, probably in one of the lymph follicles An area of acute inflammatory change with fibrin ous exudate and polymorph infiltration then forms in the submucous coat This rapidly extends in depth There is always more or less haemorrhage into the mucous membrane at this stage Such primary inflammatory segments multiply up and down the appendix, most often in the distal portion immediately beyond a normal somewhat acute bend A small amount of exudate, at first catarrhal then purulent, and often mixed with blood, accumulates in the lumen If peritonitis is present at this stage it is of a plastic or non infective type, the germs being restricted as yet to the mucous membrane All these changes may occur within twelve hours and they are found in the type of the disease known as *simple uncomplicated acute appendicitis* The process may retro gress, the exudate is absorbed, and only a small amount of pigmentation remains in the mucous membrane

On the other hand, the process may spread the various inflammatory foci uniting with another until all the coats

over a large area are affected At this stage the appendix is
swollen and erect, its surface reddened and often adherent
to surrounding parts, but beyond that little is to be seen
Microscopically, the picture is that of spreading inflammation
as seen in other situations for example in the skin in cellulitis
The various coats are permeated by a fibrinous exudate and
infiltrated with polymorphonuclear leucocytes The con-
dition is known as *acute phlegmonous appendicitis*, and, if
localised abscesses form, *acute suppurative appendicitis* Such
abscesses may rupture outwards or inwards

Areas of necrosis then form on the mucous membrane,
appearing as patches staining more or less uniformly with the
acid dye, these on separation leave ulcers (*ulcerative append-
icitis*) Ulceration is rapidly followed by penetration of
germs and extension of these to the peritoneal coat, causing
an organismal or septic peritonitis The inflammatory process
also spreads to the mesentery when thrombosis is set up in
the veins This leads to *infarction* in the appendix itself,
localised gangrene and *rupture of the viscus* At this stage
the organ is still further swollen, dark purple areas have
formed with thick fibrinous exudate on the peritoneal surface
Gaping tears in the organ with yellow necrotic margins may
occur Sometimes the later gangrenous processes are limited
to a particular area, most frequently the distal end, which is
swollen and bulbous, of a dark red or purple colour with
patches of fibrinous exudate on its surface

If the earlier plastic peritonitis has led to adhesions ex-
tension of the germs to the surface will cause a *localised peri-
tonitis* or *peri-appendical abscess* If no such adhesions have
formed, a *general peritonitis* results

Occasionally in cases in which appendectomy is not per-
formed the thrombi which have formed in the veins of the
mesentery become infected with germs Septic softening
occurs, portions of clot are detached to be caught in the
branches of the portal vein within the liver, setting up *portal*

pylephlebitis and *portal pyæmic abscess* Such is the picture in *gangrenous appendicitis* with its complications

At any of the earlier mentioned stages resolution of the process may occur One of the commonest results of an acute attack of the disease is adhesions of the organ to surrounding structures In this way it may become buried in scar tissue or merely united by its tip to some such organ as uterus, bladder, or abdominal wall, thus forming a band under which a loop of bowel may become strangulated Should ulceration have occurred obliteration of the lumen through the formation of fibrous tissue will inevitably result Such an appendix will become reduced to a thin fibrous band Rupture of an abscess leaves a track through the muscular coat This may be traced as a fibrous scar Constriction of the lumen by some of the above causes may lead to bulbous distention of the distal portion and a cyst results *Recurrent attacks* of inflammation are not infrequent in appendices which retain their lumen Occasionally a subacute inflammatory process is set up which continues for some time leading to the formation of a greatly thickened organ In the thickening all the coats participate

Tuberculous appendicitis may be primary or secondary The latter occurs in the course of a generalised blood infection from some such focus as the lung or from the peritoneum in tuberculous peritonitis The appearances presented are the usual grey or yellow tubercles usually in large numbers on the serous coat

The primary condition occurs as part of an ileo-cæcal tuberculous infection, very rarely as an infection limited to the appendix itself The appendix may show little that is characteristic of the disease, the appearances being merely those of a subacute appendicitis There is general enlargement, ulceration, and fibrous thickening and only later on peritoneal involvement The lymphatic glands in the ileo-cæcal angle show caseous tuberculosis

Actinomycosis of the appendix is similar to tuberculosis in its distribution and appearance   The disease goes on to suppuration, adhesions form in various directions with the formation of fistulous openings communicating with skin, bladder or rectum   Secondary abscesses of a characteristic type may form in the liver

The types and stages of the diseases may be recapitulated as follows

A *Acute Appendicitis*

1 *Catarrhal appendicitis*—inflammatory change chiefly located in the mucous membrane, not infrequently an extension from a similar affection of the large bowel.

2 *Simple acute appendicitis*—a patchy inflammatory change starting in the mucous membrane but penetrating rapidly and deeply into the other coats

3 *Phlegmonous (suppurative) appendicitis*—a diffuse inflammatory change involving all the coats of the viscus ; sometimes associated with the formation of localised accumulation of pus which may rupture either into the lumen or on to the peritoneal surface

4 *Ulcerative appendicitis*—a condition in which necrosis occurs in the mucous membrane with formation of sloughs, which separate leaving ulcers   In this type the organisms penetrate deeply and reach the peritoneal surface

5 *Gangrenous appendicitis*—The inflammatory process has involved the mesentery and led to thrombosis in veins, infarction and necrosis of large areas of the wall of the viscus   Rupture takes place and peritonitis is always present   Portal pylephlebitis and liver abscess may follow

B *Subacute appendicitis*—a more prolonged type of the acute in which great thickening of the viscus occurs, often associated with repeated attacks of the acute type

C. *Chronic appendicitis*—representing the healing stage of
    the less severe types of the acute variety, associated
    with thickening in some cases, in others with fibrous
    atrophy of the organ often also with adhesions to
    surrounding structures

D *Chronic specific appendicitis*—due to infection such as
    tuberculosis and actinomycosis

Microscopically, in the catarrhal type there is distention of
the vessels with blood, infiltration of the coats with exudate,
which may be fibrinous, also with leucocytes   There is, in
addition, catarrh of the mucous membrane, as evidenced by
shedding of the gland cells

In the more severe types of the disease the inflammatory
changes are more intense, there is necrosis of the mucous
membrane with ulceration   In the floor of the ulcers germs
are present in large numbers   There is also more or less
marked peritonitis

Animal Parasites —The important animal parasites
which may be met with in the intestines are —Protozoa
Entamœba histolytica, causing the tropical form of dysentery,
and *Amœba coli*, of little or no importance   *Trichomonas
intestinalis* and *Lamblia intestinalis* are flagellate protozoa
occasionally associated with acute diarrhœa in the tropics
Balantidium coli is an infusorian which sometimes causes an
ulcerative colitis   Worms (1) Trematodes—*Bilharzia hæmatobium*, which may give rise to polypoid outgrowths of the
mucous membrane of the rectum (2) Cestodes—*Tænia
solium*, the cystic stage of which is found in the pig   *Tænia
mediocanellata or saginata*, the cystic stage of which occurs in
the ox. *Bothriocephalus latus*, the cystic stage of which is
found in the pike (3) Nematodes—*Ascaris lumbricoides*,
found chiefly in the upper part of the small intestine, occasion
ally in the bile duct   *Oxyuris vermicularis*, the " thread " or
" seat " worm, found in the large bowel in children   *Ankylostoma duodenale*, the " hook," " tunnel," or " miner's " worm,

found attached to the mucous membrane of the jejunum This worm is of more importance than the other round worms, as it may cause a severe type of anæmia *Tricho cephalus dispar*, or ' whip' worm, a common inhabitant of the cæcum

Tumours —Simple tumours, such as *fibromata, lipo mata, myomata,* and *cysts* of various kinds, are occasionally met with Of malignant tumours, *sarcomata* are rare

By far the commonest type of growth in the bowel is the *carcinoma* Of these, all types may be met with squamous epitheliomata in the rectum, the various types of adeno-carcinomata, as columnar cell carcinoma, colloid cancer, scirrhous cancer The growth is usually small It may be a mere ring of infiltration round the wall of the gut, produc-ing a constriction when looked at from the outside, with narrowing of the lumen In other cases it forms a fungating growth projecting into the interior (Fig 69) Ulceration of the bowels is very commonly associated, and perforation may occur There are often adhesions with neighbouring structures, and the nearest lymphatic glands are usually enlarged and infiltrated Secondary growths in the liver are very commonly present Diffusion of the growth throughout the peritoneal cavity is sometimes seen

As regards site, carcinomata may occur at any part of the small or large intestine They are, however, much more common in the latter, occurring more especially at points of narrowing of the gut, such as the ileo-cæcal valve and the ascending colon immediately above the cæcum, at points where the intestine changes its direction, as, for example, at the hepatic, splenic, and sigmoid flexures A large proportion of cases show the growth in the lower bowel, usually 2 to 3 inches from the anal orifice

The appendix is occasionally the seat of a malignant growth of the adeno-carcinoma type This growth seems

to arise in appendices which have been previously inflamed and are partially obliterated Such tumours show little tendency to spread, being apparently of low malignancy The term *carcinoid* has been suggested for these growths

DISEASES OF THE PERITONEUM

Hæmorrhage —Small petechial hæmorrhages occur into the subperitoneal tissue in infective conditions and in severe anæmias   Free blood and blood clots in the peritoneal cavity may be due to rupture of an organ (liver or spleen) from injury, acute peritonitis, rupture of a vascular tumour, as, for example, in the spleen, or rupture of an aneurysm

Dropsy of the Peritoneal Cavity or Ascites —This condition may be found in diseases which tend to produce dropsy elsewhere, such as *chronic heart* and *renal disease*, or it may be due to *cirrhosis of the liver*   In long standing cases the peritoneum is frequently opaque and thickened The fluid is usually clear , when it is milky the turbidity is usually caused by the presence of protein bodies of the nature of globulins   Very rarely milkiness is due to the presence of fat globules (chylous ascites) escaped from an injured lacteal vessel (*e g* in filariasis)

Acute Peritonitis —This may be due to (1) spread of inflammation from structures within the abdomen, such as the appendix and Fallopian tubes or from the pleura , (2) rupture of the gut from injury or perforation associated with ulceration , (3) blood or lymph infection   It may be general ised throughout the peritoneal cavity or localised by adhesions

Naked-eye Appearances —There is more or less free fluid in the cavity, more especially in the pelvis and in dependent parts   The fluid may be yellow or brownish and contains flakes of lymph   It is often mixed with fæcal matter or stomach contents, and usually has a foul smell   The omentum is swollen and its vessels injected   There is fibrinous exudate

on the surface of the bowel, more especially between the coils of the intestine (Fig 68) The coils are thus glued together Not infrequently on separating the coils small abscesses are opened into

Microscopic Appearances of the Omentum in Cases of Peritonitis —There is distension of the vessels, exudation of fibrin on the surface and in the substance, swelling and throwing off of the endothelial cells These are found amongst the fibrin threads as large, swollen, and vacuolated cells, often containing germs and polymorphonuclear leucocytes Numerous polymorphs are found in the fibrin on the surface and infiltrating the tissue generally There is swelling of the collections of lymphoid tissue along the vessels, and many free lymphocytes are found in the exudate.

Film preparations of the exudate show numerous polymorphonuclear leucocytes in various stages of degeneration, large mononuclear cells often vacuolated and properly containing leucocytes which they have ingested, lymphocytes, and micro-organisms

Chronic Peritonitis —Large or smaller areas of thickening of the peritoneum, or rather of the subendothelial fibrous tissue of the peritoneum, are found frequently, more especially over liver and spleen They may be associated with adhesions, and are specially frequent in syphilis A more general thickening of the peritoneum is found in cases of long-standing ascites

Tuberculous Peritonitis —This may be associated with tuberculous ulceration of the bowel, but not infrequently no such lesion of the bowel can be found Usually, however, the mesenteric glands are the seat of tuberculosis The condition may also occur as a part of a generalised blood infection

Naked-eye Appearances —The coils of the intestine are commonly adherent more or less firmly to one another On separating the coils, if this be possible, there will be found covering the surface of the bowel and mesentery, also the

surface of liver and spleen, as well as the parietal peritoneum, numerous small opaque white or yellow areas, the size of a pin head or larger (Fig 70)   Often the coils of bowel are too firmly adherent to one another to be separated without tearing   The great omentum is thickened, drawn up and infiltrated with grey tubercles   Occasionally free fluid may be present   The matting of the intestines leads to interference with peristalsis   Adhesions may lead to the formation of bands under which loops of bowel may subsequently become strangulated   Occasionally rupture of the bowel may occur as the result of erosion of the wall from the peritoneal aspect

Microscopically, the appearances are those characteristic of tubercle.   Giant cells are often specially numerous and well developed.

Tumours —Growths primary in the peritoneum are rare Endotheliomata are met with occasionally growing in the form of multiple polypoid masses   Dissemination of carcinoma sometimes occurs secondary to rupture of a cystic growth of the ovary or the invasion of a bowel tumour into the peritoneal cavity.

CHAPTER IX

DISEASES OF THE LIVER

Post-Mortem Changes —In addition to the softening of autolytic change seen in cases examined some time after death the liver very frequently shows a greenish black discoloration (pseudomelanosis) due to the formation of sulphide of iron The change is most marked in those portions of the organ, such as the inferior surface which come into contact with hollow viscera An incision will demonstrate that the pigmentation is superficial

The blood in the liver vessels should be examined for gas bubbles which is due to the invasion of gas producing germs after death Should this invasion take place before death emphysema of the organ (foamy liver) due to the presence of gas cysts is produced

Deformities —A transverse sulcus across the lower portion of the right lobe of the organ is frequently seen, due to the wearing of tight corsets Perpendicular sulci are also met with, due *to folding of the liver from a similar cause*

Wounds and Rupture —Penetrating wounds, gunshot or stab, are not uncommon Tears due to crushing of the abdomen *through accident or at birth also occur If any large vessel is ruptured death rapidly supervenes owing to hæmorrhage into the peritoneum. Smaller injuries may heal leaving a scar* Spontaneous rupture occasionally occurs in tumour formations Should the tumour be vascular the hæmorrhage into the peritoneal cavity will be severe

ALTERATIONS IN THE CIRCULATION

1 **Anæmia** —Yellow or white patches are frequently seen on the surface of the organ   They are due to localised anæmia from pressure

2 **Chronic Venous Congestion.**—This condition is found in cases of *chronic valvular disease of the heart* and in *chronic pulmonary lesions*   The organ is enlarged in the early stages   In the later stages it may be smaller than normal   It has a dark purple colour with paler areas (Frontispiece, Fig 5), and is firmer than usual   On section, the cut surface shows a mottled appearance, likened to nutmeg   There are areas of congestion, dark purple in colour, and areas of fatty change, pale yellow   The branches of the hepatic vein are dilated

Microscopic Appearances —In the very earliest stage there may be little more than the deposit of yellow pigment in a zone of liver cells round the central vein.   In the later stages there is dilatation of the central veins and the capillaries draining into them, with compression and atrophy of the columns of liver cells between   The liver cells, more particularly those at the margin, may show fatty infiltration   There is some increase of the fibrous tissue of the organ in the more advanced cases

3 **Embolism and Thrombosis in the Portal Vein** — *Thrombosis* of the portal vein is sometimes found in connection with cirrhosis of the liver and malignant disease   It may also occur as the result of inflammation round a perforating ulcer of the stomach

Portions of thrombi from rootlets of the portal vein in the neighbourhood of inflammatory foci, *e g* the appendix, are caught in the branches of that vein within the liver   Secondary thrombosis occurs in connection with such emboli, the condition sometimes spreading to large branches of the

vein As the emboli contain organisms, abscess formation
is set up

As regards the effect upon the liver of blocking of a branch
of the portal vein, this may be very slight, owing to the fact
that the liver lobule is also supplied with blood from the
hepatic artery Sometimes the area supplied assumes a
darker brown, even a red colour, but on microscopic examina
tion little is seen in such an area beyond dilatation of the
capillaries The liver cells commonly show no evidence of
necrosis Occasionally, however, in such an area a partial
necrosis of the inner two-thirds of the lobule may be seen

Blocking of a branch of the hepatic artery may lead to
true infarction Only one case of this kind has come under
the author's notice The case was one of periarteritis nodosa
in which there were multiple aneurysms along the course of
various visceral arteries One of these, the size of a bean, on
the hepatic artery just within the liver was completely blocked
by a thrombus A large area of liver tissue in the distribu
tion with this vessel was the seat of anæmic infarction The
infarct was wedge-shaped, pale in colour, and on microscopic
examination the liver cells failed to stain At the margin
of this area the liver tissue was infiltrated with blood and
showed an appearance similar to that found in the red stage
of acute atrophy The student should remember, however,
that true infarctions of the liver are exceedingly rare The
condition which he is most apt to mistake for an infarct is a
cavernous angioma

DEGENERATIVE CHANGES

1 Atrophy —Atrophy of the liver occurs in conditions
such as cachexia and general malnutrition in which the other
organs of the body are similarly affected It also occurs in
old age, when the reduction in size is usually associated with
increase in pigmentation (brown atrophy) The pigment is
found in the form of granules within the liver cells of the

central portion of the lobule   It gives no iron reaction but stains with Sudan, thus revealing its lipoid nature

Acute atrophy (often known as acute yellow atrophy) is dealt with under a separate heading (p 231)

2 **Cloudy Swelling** —This is found in varying degrees in all infective conditions, and occasionally apart from infections, as in hæmorrhage of the pons where there was a markedly raised temperature during life

The organ is slightly *enlarged* and has a *pale* appearance It is soft and *friable* The last point is tested by the ease with which the finger may be pushed into the substance of the organ   On section, the cut surface has a hazy, misty appearance, described as like the effect of plunging a portion of normal liver into boiling water   The outline of the liver lobules is no longer visible   The condition may be associated with congestion of some of the vessels of the organ   It is also commonly combined with a degree of fatty change

Microscopic Appearances —The liver cells are swollen and granular   In the fresh condition the nuclei are obscured by the granules, but these are readily dissolved with dilute acetic acid, when the nucleus is rendered visible again.   The cells often show a tendency to separate from one another owing to solution of their cement substance   There may be some infiltration of the portal spaces with inflammatory cells

The condition is usually complicated with some fatty change in the liver cells   The nucleus in the earlier stages stains more intensely , in the later stages it tends to lose its characteristic staining reaction with basic dyes

3 **Fatty Change** — Two types of this condition are commonly distinguished —

(a) *Fatty degeneration*, by which is usually meant the breaking down of the chemical constituents, more especially the combinations of proteins with fatty compounds, under the action of some poison, chemical or bacterial

The organ may not be much altered in size or it may

15

be smaller than normal It is paler than usual, of a bright
yellow colour, soft, and friable On section, the parts
showing more advanced fatty change are seen as opaque
yellow areas These may be in the centre of the lobules,
or they may form a zone at the periphery, or the change
may be present throughout

Microscopic Appearances — Sections should be stained
with Sudan III, Scharlach R, or Nile blue sulphate As
already stated the change may be at the periphery of the
lobule in the centre, or throughout It is usually described
as occurring most characteristically at the centre The
globules of fat in the cells tend to be numerous and small
The nucleus shows degenerative changes either increased
intensity of staining in the early stages or loss of staining
reaction in the more advanced condition

(*b*) *Fatty infiltration* may be defined as the absorption in
excess of fatty material and the deposition of it in a demon
strable form in the protoplasm of the liver cell A rigid
distinction between this and the preceding type cannot,
however, be made *The two conditions pass into one
another and are frequently combined* Thus there is reason
to believe that in the fatty degeneration of phosphorus
poisoning the fat in the liver cell is largely derived from out
side Hence in very many cases it is safer to use the term
fatty change It is convenient, however, in certain cases to
make a distinction into two types, *the extremes of which are
readily separated from one another*

The organ tends to be larger than normal, in some
cases very markedly so It is pale yellow in colour
(Frontispiece, Fig 2) Its consistence varies in different
cases It may be softer and more friable, or it may be (in
cases where there is cirrhosis combined) firmer On section,
the change may appear most marked in the periphery of
the lobule, or it may be diffuse

Microscopic Appearances —The globules of fat within the liver cells tend to be large pressing aside the protoplasm and nucleus of the liver cell.   The change may be at the periphery of the lobule, *i e* merely an exaggeration of a change found normally in the liver during digestion, or it may be diffuse It is frequently combined with increase of fibrous tissue in the organ

4 Focal Necrosis —Areas of focal necrosis are found in the liver in typhoid fever eclampsia and other toxic and infective conditions   They appear as opaque white or yellow points scattered through the liver substance, but often they are too minute to be seen with the unaided eye   Cloudy swelling is always associated

In *eclampsia* the liver shows three characteristic changes, which may not, however, all be present in a given case (see p 343)

(1) *Hæmorrhage* under the capsule, which may be very extensive, also hæmorrhage into the substance of the organ

(2) *Fatty change*, usually most marked at the margin of the necrotic areas

(3) *Areas of focal necrosis*, usually situated at the periphery of the lobules, and often too small to be seen with the naked eye

5 Amyloid (Waxy) Degeneration — For causation of waxy change see p 124

The organ is commonly enlarged, often very much so It is anæmic and has a translucent appearance if the condition be advanced   It is firm and elastic in consistence like india rubber   On section, the cut edge remains sharp   The cut surface has the same translucent appearance   The condition is often combined with some degree of fatty change   When the cut surface is treated with a solution of iodine, the waxy areas take on a mahogany brown colour (Frontispiece, Fig 4)

Microscopic Appearances —The waxy material has a clear

translucent appearance in unstained specimens In preparations treated with methyl violet it shows a rose pink to purple colour

In the early stages the change is limited to the middle coats of the branches of the hepatic arteries and portal veins in the portal tracts It is the bands of connective tissue between the muscle fibres which show the change   Later on, the peri-endothelial connective tissue of the capillaries in the middle zone of the lobules is affected   Still later, the change becomes diffuse   The capillaries and also the liver cells become compressed by the swollen amyloid material, and occasionally little or nothing is seen in certain areas but masses of waxy tissue

6 Pigmentary Changes.—A *black coloration* of those portions of the organ nearest the intestines is often seen, due to the action of the H_2S from the gut upon the iron pigment of the organ   This is, of course, a post mortem change. *Increase in the amount of iron-containing pigment in the liver* is found in cases where there is an increase in the destruction of the red blood corpuscles within the liver, as in septicæmias and severe anæmias, notably in pernicious anæmia.   This increase of hæmosiderin pigment gives a yellow brown colour to the organ   The pigment may be brought out in a striking fashion by pouring some ferrocyanide of potassium (2 per cent) over the cut surface of the organ, and then some dilute HCl (1 per cent), repeating the process once or twice until the Prussian blue colour appears (Frontispiece, Fig 1)   Microscopic sections of the organ should be treated in a similar way   In chronic venous congestion, also in malaria, there is a deposition of pigment in the liver cells   In cases where there is *obstruction to the outflow of the bile* there is a *yellow coloration* of the organ, which becomes *green* on exposure to the oxygen of the air (Frontispiece, Fig 3)   The bile pigment may occur as a diffuse staining of the cell protoplasm or as granules within the liver cells.   Usually it is also visible

distending the smaller bile channels in the form of rounded homogeneous globules green in colour, often known as bile thrombi

ACUTE INFLAMMATIONS OF THE LIVER

1 **Acute Perihepatitis** is found as a part of a general peritonitis   The surface of the liver is covered with more or less fibrinous exudate

2 **Acute Hepatitis**—Acute inflammation of the liver substance is found in slight degree in all infective fevers   It is always combined with cloudy swelling, and may be associated with focal necrosis, as in typhoid fever   The evidences of inflammation are usually slight, being confined to infiltration of the portal tracts with inflammatory cells

3 **Suppurative Hepatitis**—In discussing the types of liver abscess the paths by which organisms may reach the liver should be called to mind   There are three, (a) *the hepatic artery*, (b) *the portal vein* draining the whole of the abdominal contents, (c) *the excretory duct of the organ— the bile duct*   Thus at once we may distinguish three types of abscess or suppurative hepatitis

There are, in addition, three other types to which special names are given

Types of Liver Abscess

    1 Pyæmic
    2 Portal pyæmic.
    3 Biliary
    4 Actinomycotic
    5 Tropical
    6 Suppurating hydatid cyst

(1) *Suppurative Hepatitis of Arterial Origin — Pyæmic Abscess* —This type is found in cases of pyæmia, septicæmia,

and ulcerative endocarditis, where there are organisms circulating in the blood of the body generally The abscesses in this case are minute and usually numerous They are scarcely visible to the naked eye, and there are similar abscesses in other organs

(2) *Suppurative Hepatitis of Portal Origin—Portal Pyæmic Abscess*—In this type the infective agent comes to the liver by way of the portal vein It is usually a germ laden thrombus from a thrombosed vein in the neighbourhood of an inflammatory focus, such as an appendicitis The abscesses in this case are usually about the size of a pea They occur in groups or clusters like bunches of grapes (Fig 71) They form cavities containing yellow or greenish pus, their walls being formed of necrosed liver tissue Septic thrombi can usually be found in branches of the portal vein (Fig 71) The condition is sometimes known as portal pyæmia

(3) *Suppurative Hepatitis of Bile Duct Origin—Biliary Abscess*—This is associated with suppurative cholangitis (suppurative inflammation of the bile ducts), which is commonly caused by obstruction to the bile passages from the presence of gall stones or a tumour The abscesses are numerous, usually minute and scattered uniformly throughout the organ The liver is bile stained Cirrhosis of the liver is not infrequently present in addition

(4) *Actinomycotic Abscess*—This is usually a special variety of the portal pyæmic abscess It is associated with a focus of infection with the *Streptothrix actinomyces* in some part of the intestinal tract, e g the vermiform appendix The affected portion of liver has a worm-eaten appearance owing to the presence of numerous small cavities containing pus, with areas of necrotic liver around, in which there is some fibrosis

(5) *Tropical Abscess*—This is usually single and fairly large (Fig 72) The process is more a necrosis of the liver substance than a true suppurative inflammation The

contents of the abscess have a pink colour and creamy consistence   The condition is commonly associated with tropical dysentery   The *Entamœba histolytica* is found in large numbers in the tissue in the margin of the abscesses, and usually in the pus also

(6) *Suppuration in a Hydatid Cyst* —In this case also the abscess cavity is large and may be solitary   Mixed with the pus there will be the ectocyst of the parasite   The cavity is usually limited by fibrous tissue

ACUTE AND SUBACUTE LIVER ATROPHY

This is a condition which is associated clinically with jaundice, vomiting, a diminishing liver dulness, and eventually coma   It is often connected more or less closely with such diseases as syphilis, tuberculosis, and influenza, and a number of cases have developed in women during the later months of pregnancy   There is a general consensus of opinion that the condition is a toxic one, but what the nature of the toxin is and where it originates has not yet been determined   A change indistinguishable from acute atrophy was occasionally found in fatal cases of jaundice amongst workers in trinitrotoluol and tetra-chlor ethane during the war   A number of instances of the disease have occurred after the intravenous injection of arsenical preparations   As these were primarily cases of syphilis some doubt has been thrown upon the arsenic as a toxic factor   Phosphorus poisoning produces a change somewhat similar to acute atrophy, but chemical analysis of the phosphorous liver shows a great increase in the amount of fat, whereas in acute atrophy the amount of fat is usually not above the normal   Although in acute atrophy at a certain stage of the disease fat can be demonstrated microscopically in large amount, having been set free from combination with protein, the change is much

more a necrosis than a fatty degeneration In delayed chloroform poisoning the appearances in the liver are somewhat similar to those seen in phosphorus poisoning, but the change, as in phosphorus poisoning, is more of a fatty degeneration than a necrosis Some recent German writers emphasise the importance of an ascending infection from the alimentary canal by the bile channels in cases of acute atrophy

Two stages in the disease may be recognised, and, as a result, two types of cases are met with *post mortem*

(1) *Acute cases* in which death occurs within one or two weeks of the onset of the symptoms, and in which *degenerative changes* predominate in the liver There is usually little evidence of overgrowth of fibrous tissue To this type the name "acute yellow atrophy" or ' acute liver atrophy" is more particularly applicable

(2) *Subacute cases*, lasting some weeks, or even months, in which there is more or less evidence of the *reformation of functioning liver tissue with overgrowth of fibrous tissue* For such cases the terms "subacute yellow atrophy," " subacute liver atrophy," and for the cases with marked regeneration "multiple nodular hyperplasia," have been suggested

(1) Acute Atrophy—*Naked-eye Appearances* —The liver is reduced in size, often markedly so Its capsule tends to be shrivelled The organ shows, as a rule, areas of different colours, yellow and red In the more acute types the yellow areas predominate.

Microscopic Appearances —In the *yellow areas* the liver cells are usually visible, but they show marked evidence of degenerative changes. They are swollen, granular, frequently contain fatty globules, and their nuclei have to a great extent lost their staining reaction. In addition, there is usually more or less overgrowth of fibrous tissue extending from the portal tracts. This fibrous tissue is vascular and cellular. In the neighbourhood of the portal tracts are small vermiform strings of cells whose nuclei stain deeply Sometimes these have an

obvious lumen   They represent the remains of pre existing and of proliferating small bile ducts   In process of degener ating the liver cell undergoes coagulation of its substance, followed by disappearance first of the carbohydrate and fatty elements, second of the albuminous constituents.

In the *red areas* little that is characteristic of liver structure remains   The tissue is a vascular connective tissue with dilated capillaries, and shows large numbers of endothelial cells which may contain pigment, a loose connective tissue stroma, occasional degenerated liver cells scarcely recognisable as such, and a few leucocytes.   In the neighbourhood of the portal tracts the small bile ducts are numerous, and may show evidence of proliferation of their cells (mitotic figures).

(2) Subacute Atrophy — *Naked eye Appearances* — The organ is of a brownish red colour, with yellow or greenish nodules varying much in size, sometimes projecting beyond the general surface (Fig 73)   On section, these yellow nodules may be isolated, or may be found scattered through the sub-stance of the liver   Where the nodules are numerous the organ presents the appearance of a coarse cirrhosis, from which condition it is often very difficult to distinguish it

Microscopic Appearances — The red brown portion of the organ consists of a fairly vascular connective tissue with groups of small bile ducts, scattered endothelial cells, and, as a rule, with no liver tissue to be found   The yellow nodules present the appearance of liver tissue.   They are composed of masses of liver cells, sometimes arranged in columns, at other times closely packed together   Lobular arrangement is imperfect. Many of the cells are large and multinucleated, some may be found showing mitotic division of their nuclei   The appear ances at the margin of these nodules suggest that they are enlarging and pressing aside the surrounding tissue   The fibrous tissue, being newly formed, contains few elastic fibres.

It will thus be seen that the disease is essentially a degeneration of the liver parenchyma under the action of some poison   Complementary to this, there is an overgrowth of fibrous tissue starting from the portal tracts.

The condition may thus be regarded as an acute cirrhosis It forms a connecting link between the purely degenerative changes, such as occur in phosphorus poisoning, and the chronic interstitial inflammations or cirrhoses

Following the degenerative changes, attempts, more or less successful, are made to regenerate liver tissue in two ways (1) By proliferation of the bile ducts This, although it is an imitation of the way in which the liver lobules are produced in embryonic life, seldom results in the formation of liver parenchyma (2) By proliferation of liver cells which survive the destructive influence of the poison, with resulting formation of nodules of glandular cells more or less resembling in structure liver lobules, and probably functioning as such.

Healing and Regeneration.—After injury and destruction of its tissue the liver is capable of a very complete renewal of its substance The author has in his museum a liver the right lobe of which is almost entirely destroyed by a syphilitic gumma, while the *left lobe has enlarged to approximately the* same size as the right is normally Any slow destruction of the liver tissue is accompanied *pari passu* by regeneration This is seen in conditions such as chronic venous congestion and cirrhosis The large size of some of the nodules in the latter condition is due in no small degree to regenerative hyperplasia After massive destruction of liver tissue as in acute and subacute atrophy if the patient survive, regeneration is often wonderfully complete but owing to the fibrous tissue laid down in the atrophic stage the individual areas of regenerated tissue are separated more or less widely by bands of fibrous tissue. This condition of *multiple nodular hyperplasia* is in its more complete form almost impossible to distinguish by the unaided eye from cirrhosis Microscopically, in the regenerating areas in all these conditions there is a loss of lobular arrangement, the liver cells are larger and frequently contain more than one nucleus Nuclei are rarely

seen in the condition of mitosis, however   The regeneration
of the liver tissue takes place from two sides, chiefly from the
pre existing liver cells, but also from a multiplication of the
small bile ducts   It is only after a linking up of these two
structures that the newly formed liver tissue can function

CHRONIC INFLAMMATION OF THE LIVER

Cirrhosis

The term " cirrhosis," introduced by Laennec, simply
means " yellow "   It has, however, come to be synonymous
with fibrosis, and is applied to all conditions of the liver
in which there is abnormal development of connective
tissue

The condition is *caused by any slowly acting poison* or
irritant   Thus *chronic intoxications*, such as alcohol or lead,
produce it   *Infective conditions*, such as syphilis, may also
cause it   *Retention of the bile* from obstruction to the bile
ducts will produce it, also *inflammatory conditions of the
small bile ducts*, which so commonly accompany obstruction
Lastly, *abnormal accumulation of pigment*, as in malaria,
chronic venous congestion, and hæmochromatosis, is a
factor

The liver consists of two types of cellular elements   (1)
highly differentiated and functioning gland cells very sus
ceptible to the action of poisons, and capable of little in the way
of reaction , (2) cells less highly differentiated—connective-
tissue cells—not so readily damaged by the action of poisons,
and capable of reaction and proliferation in circumstances
where the liver cells degenerate   The mere disappearance
of the glandular cells is followed by a complementary pro-
liferation of connective tissue   This is well seen in the less
acute types of liver atrophy   But where there is an irritant
constantly present, as in syphilis, alcoholism, retention of

bile and inflammation of the small bile ducts another factor
comes into play, namely, the proliferative reaction of the
connective tissue cell under irritation These two factors
are, no doubt, both operative in the production of cirrhosis
of the liver

Where there is any great amount of destruction of hepatic
gland cells the stimulus to regenerate is felt by the organ,
and is answered by the formation of new areas of liver tissue
This is a prominent feature in subacute liver atrophy, and
evidence of it is usually present in cirrhosis also

Classification —The terms *monolobular* (where the areas
of liver cut off by bands of fibrous tissue represent single
lobules) and *polylobular* (where such areas represent groups
of lobules) are often used to characterise types of cirrhosis
They are practically the same as fine and coarse cirrhosis
respectively They are not very useful as a basis of classifica
tion owing to the fact that the two conditions are usually
to be seen alongside one another in the same liver Another
couple of terms used sometimes are hypertrophic (meaning
an abnormally large liver) and atrophic (abnormally small)
Owing to the fact that in many instances it is impossible to
decide whether a liver is enlarged or not these terms are
rather to be avoided The method of classification adopted
is as follows —

A Common Cirrhosis —The ordinary type found in asso
ciation with chronic intoxications distinguishing (*a*) an early
stage where the liver is large and (*b*) a late stage where it is
small This variety is usually polylobular

1 *Early Stage* —The liver is *enlarged* and has a *somewhat
rough surface* In some cases it is red from congestion , in
other cases it is yellow, from fatty change

The organ is *firmer* and *tougher* than normal and on
section shows *bands of vascular fibrous tissue* running through
it These, as a rule, are not very obvious

Microscopic Appearances —Bands of vascular and cellular connective tissue divide up the liver into areas, at one time representing a single lobule, at another time a group of lobules The liver cells may show little change, or there may be more or less fatty infiltration

2 *Advanced Stage* —This is the more common type of the disease, known as "hobnail," "drunkard's," or "gin drinker's" liver, also as atrophic cirrhosis

The liver is *distinctly reduced in size* It has a *roughened surface*, owing to the presence of nodules varying much in size It usually has a *pale yellow colour* The *capsule* may be *thickened* It is distinctly *tougher* and *firmer* than normal On section, it shows *bands of grey fibrous tissue* passing through the organ in all directions, dividing it up into rounded areas varying much in size (Fig 74) A number of cases are recorded in which primary carcinoma of the organ was associated with this type of cirrhosis

Microscopic Appearances—The most striking change is the overgrowth of fibrous tissue which spreads from the portal tracts, forming bands, thicker or thinner, cutting off individual lobules or groups of lobules This fibrous tissue is well formed, but it often shows here and there accumulations of small round cells, indicating that the fibrous proliferation is still progressing There is considerable development of new elastic fibres in the bands of fibrous tissue There is a varying number of small bile ducts These in some cases appear to arise from retrograde changes in columns of liver cells, the latter reverting to their embryonic condition under the pressure of the surrounding fibrous tissue In other cases the ducts represent an attempt to reform liver tissue, just as in subacute liver atrophy There is a tendency for the fibrous tissue to invade the liver lobule at its margin to a certain small extent, individual liver cells or groups of them being cut off The liver cells themselves commonly show more or less fatty infiltration Not infrequently small nodules of regenerated liver tissue are met with. These are recognised by the evidence of multiplication in the liver cells, some of them having two nuclei, others showing evidence of division Such nodules also show imperfect lobule formation

B Biliary Cirrhosis —This condition is commonly associated with *obstruction to the bile ducts* This may be due to congenital obliteration, to gall stones, or to tumour It is also very commonly associated, as, indeed, obstruction is, with *inflammatory conditions of the bile ducts*

The organ is sometimes enlarged, sometimes reduced in size Its surface is not so rough as in common cirrhosis It is a much finer cirrhosis, corresponding more to the monolobular type The organ usually has a *deep yellow colour*, turning green on exposure to the air, due to the bile staining which so constantly accompanies it The organ is firmer and tougher than normal On section, bands of fibrous tissue can be seen radiating through the liver tissue and dividing it up into small lobules which have a yellow or green colour Sometimes abscess formation of biliary origin is present Clinically the condition is characterised by enlarged spleen and jaundice, but not by ascites

Microscopic Appearances —As in the common type, the most striking change is an overgrowth of the fibrous tissue of the organ, extending from the portal tract and tending to separate individual liver lobules from one another The fibrous tissue is, on the whole, more cellular than in the common type of cirrhosis, and small bile ducts are a more conspicuous feature. The liver cells show marked degenerative changes, areas of necrosis being frequently met with Bile pigment may be seen in and between the liver cells. Catarrhal changes in the bile ducts, sometimes with the development of abscesses, is common In suitably stained specimens germs may be found, especially where abscess formation is present.

C. Hanot's Cirrhosis —This is a rare condition characterised clinically, like the biliary type, by jaundice and enlarged spleen, but not by ascites The liver is greatly enlarged, is tough in consistence, but the surface is smooth The cut surface is yellowish red in colour and shows no obvious lobulation. Microscopically, there is increase of fibrous tissue

within the lobules as well as between them   The structure
of the organ thus has to a great extent disappeared owing
to the liver tissue being broken up into small groups of cells

Another rare type of cirrhosis occurs in relation to excessive
pigmentation of the liver with hæmosiderin   The disease is
known as *hæmochromatosis*, and the pigment occurs in other
tissues such as skin, pancreas, and testicle   The liver is
enlarged, firm, and brown in colour, with a rough surface

Cirrhosis of the liver is also an accompaniment of Banti's
disease and of the rare cerebral affection, Wilson's disease,
which is primarily a degeneration of the two lenticular nuclei

D Syphilitic Cirrhosis (see Syphilis)

Results of Cirrhosis—Owing to the pressure of the con
tracting fibrous tissue upon the branches of the portal vein
within the liver, there is obstruction to the blood passing
through the organ and coming from spleen and bowel, with
the following results —

1 Ascites or dropsy of the abdominal cavity

2 Chronic venous congestion of œsophagus, stomach,
intestine, and spleen, with a tendency to chronic catarrh,
varicose veins, hæmorrhage, and, in the case of the spleen,
enlargement

These two changes occur especially in common cirrhosis

3 Jaundice, which is more characteristic of biliary
cirrhosis

Syphilis of the Liver

(*a*) *Congenital*—In this type of the disease a diffuse
cirrhotic condition is sometimes met with (congenital
syphilitic cirrhosis)   The organ is enlarged, commonly bile-
stained, firmer than normal, but otherwise little altered

Microscopic Appearances—The organ is the seat of a
diffuse overgrowth of fibrous tissue   This is more marked in
some places than in others.   It is not specially restricted to
the portal tracts, on the contrary, it is found within the lobule
separating groups of cells and individual cells from one

another In the fibrous tissue are to be found numerous small round cells aggregated in places into small masses, sometimes with caseous centres (*miliary gummata*) In suitably treated material, spirochaetes may be demonstrated in large numbers

(b) *Acquired* —In acquired syphilis the lesions found in the liver are—

1 *Areas of chronic perihepatitis*, sometimes with adhesions to the abdominal wall and diaphragm

2 *Gummata* —These are caseous foci surrounded by a zone of fibrous tissue (Fig 75), sometimes with cirrhotic change radiating from it into the liver substance They may occur singly or in groups They are frequently absorbed, leaving behind scars which show themselves as puckerings on the surface When these are numerous, sometimes a *coarse cirrhotic* condition is produced, with marked deformity of the organ Waxy degeneration is sometimes combined with the above.

Tuberculosis of the Liver

Tuberculosis seldom develops to any extent in the liver, that organ apparently not forming a suitable nidus for the growth of the tubercle bacillus Two types of the disease are found —

(a) *Miliary Tuberculosis* —Small scattered foci which may or may not be visible to the naked eye When visible, they appear as minute white or yellow spots, sometimes they are bile-stained Similar areas are found in other organs

Microscopic Appearance — Numerous cellular areas are scattered through the organ They are made up chiefly of large and small mononuclear cells. They may have caseous necrotic centres or may show giant cells.

(b) *Larger caseous nodules*, which may be single or numerous, and are usually bile-stained This is a rare type, more commonly met with in children than in adults Fibrosis of greater or less degree accompanies the disease Thus some authorities distinguish a tuberculous type of cirrhosis

Leukæmia of the Liver

The organ is usually enlarged, paler than normal, sometimes with distinct, small, whitish areas scattered through it

Microscopic Appearances —There is infiltration of the liver substance with rounded cells, which vary in type according to whether the condition is myelæmia or lymphæmia   These cells are found in the portal tracts and between the columns of liver cells   In the more advanced cases the individual liver cells may be separated from one another   Here and there are cell accumulations without any liver structure   These are the above mentioned pale areas   The endothelial cells of the capillaries are swollen

Lymphadenoma (Hodgkin's Disease)

The liver may or may not be affected in this condition When it is, numerous irregularly shaped pale areas similar to those seen in the spleen are scattered through it   The condition is sometimes indistinguishable from true tumour formation   In most cases, however, the pale areas are more diffusely distributed, smaller, and less well defined

Microscopically, the appearance of the areas is similar to those found in the spleen in the same disease (see p 129)

Tumours

A. Simple growths of the liver are not common   The *cavernous angioma* is the one most frequently found   It appears as a dark red area under the capsule of the organ On section, it is found to be more or less irregularly wedge-shaped   On close inspection, bands of white fibrous tissue may be seen dividing the area up into spaces filled with blood (Fig 76)   Its appearance is suggestive of an infarct, but it should be remembered that true infarction of the liver does not occur

Adenomata of the liver are occasionally met with   They appear as circular, well-defined nodules in the substance of the organ, yellow or reddish brown in colour   They usually are single or multiple, and microscopically show an approxi

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mation to the normal structure of the liver, but without the regular lobular arrangement Areas of regenerated liver tissue have a somewhat similar appearance Occasionally simple adenomata with acinous structure and originating from the bile ducts, occur Such have the appearance of grey, well defined nodules in the liver substance

B. **Malignant growths** are very common in the liver

Primary growths are not very frequent, but *secondary growths*, more particularly carcinomata, are very common The venous blood from the various portions of the bowel passes through the organ and is naturally strained of any emboli, tumour or otherwise in it Inasmuch as the malignant growth of the bowel is almost invariably a carcinoma, the secondary malignant neoplasms of the liver are commonly of this type

It is seldom possible with any great amount of certainty, to decide from its appearance whether a tumour is sarcoma or carcinoma primary or secondary The growth, or growths, appear as white or yellow areas scattered through the substance of the organ varying in size rounded or irregular in shape The liver is often greatly enlarged (Fig 78) In the tumour masses necrotic areas, and hæmorrhages are commonly seen Owing to sinking in of the necrotic centres the masses on the surface often show crater like hollows The intervening liver substance frequently shows bile-staining, and occasionally jaundice The connection between primary cancer and cirrhosis is well recognised

1 *Primary cancers* of the liver are of two types —

(1) A type resembling more or less closely the structure of the liver, the tumour cells occurring in columns

(2) A type arising from the bile ducts and resembling other adeno-carcinomata

The association between primary cancer and cirrhosis of the liver has already been noted

2 *Secondary cancers* vary very much in appearance

and in character All types of adeno-carcinoma of the
bowel—columnar cell, scirrhous, encephaloid, colloid occur,
also chorionepithelioma

Of sarcomata (Fig 77) only the melanotic shows appear-
ances which are distinctive

Cysts of the Liver

Congenital cystic disease is sometimes met with in the
liver, although not so frequently as in the kidney The
cysts are numerous, vary in size, and contain clear fluid

Hydatid cysts are relatively frequent in the liver They
often attain a very large size, are surrounded with a fibrous
capsule, and contain ecto and endo-cyst, with the character-
istic " white of egg " appearance (Fig 79)

Gas Cysts of small size, caused by the development of
bubbles of gas in the liver substance through the action of
an organism (*B aerogenes capsulatus*, also called *B Welchii*),
are occasionally met They are found in association with sup-
puration in the abdominal cavity Pressure upon the liver
produces a sensation of crackling, such as is normally present
in the lungs Microscopically, spaces representing dilated
vessels are found lined with a layer of bacteria A similar
change may be present in other organs, *e g* pancreas

The organism causing this condition is a normal inhabitant
of the intestinal tract and is often found in the blood in cases
where the sectio is deferred for some time after death The
blood in such cases has a frothy appearance Occasionally
this invasion of the blood occurs during life when the above
appearances are produced in the liver and other organs

Method of Examining a Liver Removed from the Body

The general size, colour, and shape of the organ should be
noted, also the appearance of the lobules as they shine through
the capsule The capsule is then examined for evidence of

adhesions with the abdominal parietes, for depressions such as are produced by gummata, for the fine or coarse generalised roughening of cirrhosis, also for the fibrinous exudate of acute peritonitis and the caseous foci of tuberculous peritonitis The organ is weighed, the normal weight of the liver being 45 to 58 oz (1420-1649 grm) It is opened up by a series of perpendicular cuts In so doing the consistence of the organ is noted Pressure is made upon the cut surface in order further to investigate this point. The cut edge should be looked at in order to see whether it is rounded (indicating soft consistence) or sharp The cut surface is then investigated as to colour, the presence of abscesses, tumours, etc. Lastly, the gall bladder is opened up, and the amount of bile, also its colour noted Gall stones should be searched for

DISEASES OF GALL BLADDER AND BILE DUCTS

Post-Mortem Change —Gall bladder lesions should as far as possible be studied in fresh material obtained at operation. Owing to the rapidity with which post mortem change takes place autopsy material is useless for demonstrating the finer alterations of the mucous membrane This rapid change is due to the action of the bile on the mucous membrane after death

Congenital obliteration of the common bile duct is a condition occasionally met with The exact cause is unknown, but it is believed to be, in some cases, syphilitic in origin It is associated with a fine cirrhosis of the liver and bile pigmentation of that organ as well as jaundice

Jaundice or Icterus —Although the subject properly belongs to text books of general pathology, a few words may be said about jaundice as it is seen in the post mortem room Jaundice may be defined as the absorption of the bile pigment into the blood with consequent staining of the tissues In

addition to the pigment the bile salts are absorbed, forming the chief toxic agents In slightly marked cases the yellow tinge should be sought for in the sclerotic of the eye In more marked instances there is a general yellow staining of the skin which in extreme cases assumes a greenish colour owing to the oxidation of the bilirubin and formation of bili verdin The internal organs are more or less affected by the staining, taking on as a result a yellow colour which changes to green on exposure to the air The organs and tissues most affected are liver, kidneys, and endocardium The urine, exudates, and transudates are coloured, and in marked cases of obstructive jaundice the stools are clay like in appearance

-The more important causes of jaundice may be classified into three groups   1 Jaundice due to obstruction to the entrance of bile into the intestine, as by swelling or thicken ing of the walls of the bile channels, the presence of an obstructing gall stone in the main bile duct, or the pressure of a tumour, *e g* a carcinoma of the head of the pancreas

2 Jaundice due to diseases of the liver in which there is more or less destruction of liver tissue, *e g* acute liver atrophy

3 Jaundice due to increased destruction of red blood cells or to hæmolysis, as in septicæmia, pyæmia, pneumonia, and pernicious anæmia In this last type the yellow coloration is usually slight and may be limited to the neck and upper part of the thorax

Inflammation of Gall Bladder (Cholecystitis), of Bile Ducts (Cholangitis)

Catarrhal Inflammation —A mild degree of inflamma tion of the bile passages is sometimes associated with a catarrhal condition of the stomach, and, owing to the low pressure at which the bile is excreted, blocking of the bile passages from swelling of the walls, with resulting jaundice, may occur A similar condition is sometimes brought about

further invasion of organisms such as the B typhosus in typhoid fever The bacilli in all probability reach the bile ducts from the blood by way of the liver, but it is possible that they pass upwards from the duodenum In the gall bladder and larger bile ducts a catarrhal inflammation is set up which may persist for months or years after the attack of fever In many instances this inflammatory change leads to gall stone formation When the typhoid bacillus is the cause of this condition the patient suffering from it is constantly voiding with his stools living virulent organisms, which may contaminate food or drink and lead to the dissemination of the disease Such individuals are known as ' typhoid carriers

Suppurative inflammation of the bile ducts (suppurative cholangitis) is a very common accompaniment of obstruction to the outlet of the bile from gall stones or tumour formation The organisms found are usually staphylococce or B coli The condition results not infrequently, in abscesses (biliary) within the liver substance In cases of prolonged inflammation the walls of the bile ducts are thickened, and if obstruction is present they are dilated

Suppurative Cholecystitis (empyema of the gall bladder) — This may occur with or without cholangitis As a rule this condition supervenes after prolonged or repeated attacks of inflammation so that the wall of the gall bladder is thickened, sometimes to a marked degree The interior is congested and shows areas of haemorrhage and more or less extensive ulceration It may pass on to necrosis and gangrene with consequent acute peritonitis or if adhesions have formed, suppurative inflammation in the tissues around Con cretions are very commonly present in such gall bladders In the event of rupture these may escape into the peritoneum, or by ulceration through adhesion into the large bowel

Dilatation of the Gall Bladder —Obstruction to the cystic duct usually by a gall stone leads to distention of the gall

bladder   The contents are turbid and consist of bile diluted
with mucus

Biliary Concretions or Gall Stones (Cholelithiasis)

Gall stones are much more common in women than in
men, something like three-quarters of the cases occurring
in the female sex.   They usually make themselves felt
about the age of forty, although, not infrequently, the
stones are found post mortem without there being in the
history of the case anything to indicate their presence   As
regards *causation*, tight lacing, good living, and sedentary
habits are predisposing factors, but the actual cause of the
condition is commonly a catarrhal inflammation of the bile
passages associated with the presence of organisms   Aschoff
distinguishes two types of gall stones   (1) Those produced
by congestion of bile and disturbances of metabolism , the
stones belonging to this category consist almost entirely
of cholesterin   (2) Those caused by inflammatory change
due to the presence of organisms   The germs which have
been separated, in some cases actually from the interior
of the stones themselves, are *staphylococci, B coli*, and *B
typhosus*   The mode of formation of the concretions is as
follows   a nucleus of *mucus* and *epithelial debris* is formed,
and round this are deposited *cholesterin* (largely derived from
disintegrated epithelium), *lime and magnesium salts*, and *bile
pigment*   Cholesterin is the main constituent, being present
usually to the amount of 70-80 per cent , hence the lightness
of the stones   Some stones are formed almost entirely of
cholesterin   The colour, which varies from pale yellow to
black, depends upon the amount of bile pigment present
The concretions vary much in size, from minute particles
(gall sand) to masses measuring, it may be, two inches across
Those formed in the bile ducts are usually small , the larger
ones develop in the gall bladder   Gall stones are usually

multiple, hence commonly faceted (Fig 80) Sometimes they have a mulberry like surface and occasionally they are smooth The smooth stones are, of course, solitary On section, the concretions often show concentric lamination, sometimes they exhibit radiating lines

As regards the *effects* of the presence of gall stones, they tend to keep up the chronic irritation which caused their formation Thus they lead to thickening of the gall bladder and bile ducts and to adhesions to surrounding parts More acute, suppurative inflammation may be set up They may ulcerate through into the intestine and, when very large, have been known to cause intestinal obstruction They may obstruct the cystic duct, thus leading to atrophy, or, in some cases, to dilatation of the gall bladder They not infrequently obstruct the common bile duct and give rise to jaundice Lastly, there is a very definite relationship between cancer of the gall bladder and the presence of gall stones Gall stones are also an important factor in acute inflammation of the pancreas In spite of the frequent occurrence of pronounced lesions in connection with biliary concretions, it should be remembered that not infrequently a normal bladder filled with stones is found at an autopsy with nothing in the history of the case to suggest that the patient at any time suffered from symptoms associated with the gall bladder or bile ducts

Tumours.—The *carcinoma* is the most important tumour of the gall bladder It is usually a columnar cell adeno-carcinoma, but may be a scirrhus or colloid cancer, or even a squamous epithelioma

DISEASES OF THE PANCREAS

The pancreas is an organ which *tends to show marked post mortem changes,* partly because of the action of the digestive juices which it secretes, partly because of its proximity to

stomach and intestine, and so to infection with putrefactive germs   Thus, just as in the case of the stomach, so with the pancreas, the pathologist must be careful not to regard as evidence of disease, changes which are merely due to altera tions taking place after death

Where a lesion of the pancreas is suspected, careful search should be made for *areas of fat necrosis*   Conversely, the presence of these areas of fat necrosis is evidence of a lesion of the pancreatic gland   Such areas are found in the fat of the pancreas itself, of the mesentery and omentum, occasionally even of the mediastinum   They appear as opaque white spots the size of pin heads, or even as large as peas   The change in the fat is brought about by a setting free in the peritoneal cavity of the fat-splitting ferment of the pancreas   The neutral fat is at first split into fatty acid and glycerine, the fatty acid probably combining subsequently with a calcium base

Atrophy of the pancreas is sometimes met in old age and wasting diseases   In diabetes not infrequently the only alteration found is a diminution in the size of this organ   In old age, along with the diminution in size a brown colora tion is observed

Toxic Change —Owing to the rapidity with which auto-lytic softening occurs in the pancreas it is difficult to demon-strate the finer alterations due to toxic change   Cloudy swelling occurs as in other parenchymatous organs, as also fatty degeneration   Another degenerative change, the result of the action of toxins or of exhaustion of the cells, is seen in the epithelial elements of the islands of Langerhans in severe cases of diabetes   This condition, in which the cells are swollen and vacuolated, has been called *hydropic degeneration*

Fatty infiltration, or penetration of fat into the sub-stance of the gland, with atrophy of the gland tissue, is occasionally seen

Hæmorrhage—Small multiple hæmorrhages are found not infrequently in toxic diseases Larger hæmorrhages occur in association with degenerative and inflammatory conditions Rarely hæmorrhagic infarction may occur, most often in stout people, with escape of blood into the surrounding tissue, sometimes with sudden death ensuing from pressure upon the solar plexus

Inflammation

1 *Acute Hæmorrhagic Pancreatitis*—This is a somewhat rare condition, the etiology of which is not quite clear The symptoms are those of acute intestinal obstruction In many instances it is an acute infective process due to the presence of germs, and it is not infrequently found in association with cholangitis and gall stones which may be found blocking the ampulla of Vater Regurgitation of bile into the pancreatic ducts occurs under these circumstances This is probably the determining factor in the condition in such cases Some regard the hæmorrhage as the primary change, others consider that it is, like the fat necrosis, due to the setting free of the digestive juices of the organ and the action of these upon the blood vessels

As regards appearances, the organ is swollen and dark red in colour, due to infiltration with blood In the early stages the organ is firm Later on, owing to degenerative changes, it becomes soft More or less extensive fat necrosis is always found in the fat in the neighbourhood

Microscopically, areas of necrosed pancreatic tissue are found, also infiltration of the intervenous tissue with red blood corpuscles, fibrin, and leucocytes The areas of fat necrosis are well brought out with Nile Blue, which stains the necrosed fat blue, the normal fat red

2 *Suppurative Pancreatitis*—Organisms may reach the pancreas by way of the blood-stream or by the duct of Wirsung, or again by extension from neighbouring parts The

abscesses may be minute and numerous or large and solitary
Sometimes the change is associated with suppurative cholan
gitis and gall stones   The abscesses may rupture into the
peritoneal cavity and cause peritonitis

3 *Chronic interstitial pancreatitis* or *cirrhosis of the pancreas*
may be met with in association with alcoholism, syphilis, and
obstruction to the duct of Wirsung by calculi or tumour
formation   The organ is enlarged in the early stage   Later
on it becomes reduced in size   In all cases its consistence is
increased, it is pale in colour, and its surface more nodular
than usual   In hæmochromatosis or bronze diabetes, in
addition to the fibrous change, there is pigmentation of the
gland with hæmosiderin which gives to the organ a brown
colour   In some cases of diabetes a fine fibrosis involving
more especially the islands of Langerhans, has been described

Tumours —Primary carcinomata are occasionally met
with   By pressure upon the common bile duct such tumours
cause an extreme degree of jaundice   Many of the cases of
so-called malignant jaundice are due, not to a neoplasm in
the pancreas, but to some secondary deposit in a retroperi
toneal gland in the neighbourhood   As a rule these carcino
mata are of the encephaloid variety, but columnar cell and
scirrhous types also occur

Cysts —The pancreas, like the liver and kidneys, is
sometimes the seat of congenital cystic disease   Such cysts
are multiple and small   Large solitary cysts are also met
with, due in all probability to obstruction of a duct of the
gland

Relationship between Lesions of the Pancreas and Diabetes —
Since the middle of last century a relationship between changes
in the pancreas and the disease diabetes has been recognised.
In 1889 it was shown by Minkowski that total extirpation of
the organ produced a fatal diabetes   Ligature of the duct
was, however, not found to have this effect   As was shown by
Schultze and also independently by Sscobolew, complete blockage

of the secreting ducts is followed by a degeneration which involves the cells of the acini, but not those of the islets of Langerhans. It was this fact, confirmed by other observers, which led Banting in 1921 to the discovery of a hormone in the pancreas capable of lowering blood sugar in a marked degree. In collaboration with Best, Banting ligated the ducts of the pancreas in several dogs; a few weeks afterwards killed the animals, excised the partially degenerated gland still containing islet tissue, extracted it, and found that intravenous injection of the extract into depancreated animals caused marked lowering of the blood sugar and a fall in the sugar excreted in the urine. Thus the relationship between the active hormone and the island tissue of the gland was established, and the demonstration of two types of tissue in the pancreas with distinct functions completed.

Previous to the discovery of the active hormone, Opie described definite histological changes in the islets of Langerhans in patients dying of diabetes mellitus, but it must be admitted that these changes were by no means constant. They consisted in fibrosis and hyaline change in the connective tissue of the islet. The islet consists of a fibrous capsule with a delicate connective tissue reticulum carrying blood vessels, amongst which are epithelial cells having different tinctorial reactions. It may be that when the finer histology of the islet is worked out some constant alteration will be discovered, but meantime it can only be stated that in some cases of fatal diabetes lesions of the pancreas are found, in others none, and the changes which are found are by no means constant. In acute cases of diabetes in man a swelling and vacuolation of the epithelial elements of the Langerhans islands has been described. This has been termed hydropic degeneration. In other cases the epithelial cells are small and atrophied, often the whole organ is markedly reduced in size. In the more chronic cases hyaline change in the islet tissue and increase of fibrous tissue with pressure atrophy of the epithelial elements may be found. Sometimes the fibrosis is a more diffuse one involving the pancreas as a whole. In such cases the term cirrhosis is applied. This is associated with the presence of large quantities of hæmosiderin pigment in hæmochromatosis or bronze diabetes.

CHAPTER X

DISEASES OF THE KIDNEY AND BLADDER

DISEASES OF THE KIDNEY

Post Mortem Changes — The kidney rapidly undergoes degenerative changes after death, and if the sectio be not performed within a reasonable time it becomes very difficult to distinguish post mortem changes from disease   To the extreme form of this post mortem change the name autolysis is given   It affects the kidney epithelium primarily, the nucleus of the cells ceasing to stain and the protoplasm breaking up into granules and sometimes even into lipoid material which gives myelin figures

Red (hæmoglobin) staining particularly of the connective tissue of the organ is another post mortem change, and greenish black discoloration of the parts in contact with bowel also occurs from penetration with sulphuretted hydrogen gas and formation of sulphide of iron

CONGENITAL ANOMALIES

Persistence of Fœtal Lobulation is a fairly common finding It is best seen after stripping the capsule from the organ, and shows itself by a series of intersecting lines dividing the *organ into irregularly shaped areas*

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Horse-shoe Kidney a condition in which the two organs are united usually at their lower end across the vertebral column, is not infrequently found

Congenital Cystic Kidney —In this condition which is always bilateral the organ is enlarged often greatly so The outer surface is studded with projecting cysts, with transparent contents varying in size from something just visible to a walnut In some cases there is very little kidney left between the cysts On section a similar appearance is seen (Fig 81) The condition is believed to be due to a failure of union between the glomerular and the tubular portions of the kidney tissue which are developed separately

Solitary congenital cysts sometimes of large size, may be met with

Congenital Hydronephrosis may occur in one kidney owing to defective formation of the ureter

CIRCULATORY CHANGES

1 Hæmorrhage into the kidney substance is a constant accompaniment of infarctions and acute inflammatory conditions such as abscesses It occurs at the margin of the lesion, and is due to the escape of blood from degenerated capillaries Hæmorrhages into the glomerular space and into the tubules are a feature of some types of acute nephritis, the lesions appearing as minute red points to the naked eye A condition known to the surgeons as essential hæmaturia is of uncertain origin The blood often in large quantities, is passed continuously or intermittently When the kidney has to be removed to stop the bleeding, the organ is usually found to be almost normal It is probable that the bleeding is from some fairly large vessel which is atheromatous

2 Chronic Venous Congestion.—This condition is found

in cases where there is obstruction to the passage of blood through the heart or lungs

Naked eye Appearances —The organ is somewhat enlarged It is firm On section, the medulla has a dark purple appearance, the cortex is paler than the medulla, but shows dark lines and dots indicating vessels and glomeruli On stripping the capsule, the venæ stellatæ are often very prominent

Microscopic Appearances —The vessels generally are dilated, more especially those of the medulla. The glomerular capillaries are distended Sometimes hæmorrhages into the tubules are seen Catarrhal and interstitial changes may be superadded

3 Infarction.—Infarcts of the kidney are common They are almost invariably due to embolism of one of the branches of the renal artery Occasionally the whole vessel may be blocked The embolism may be caused by the impaction of portions of thrombi from vegetations on the aortic or mitral valve thrombi in the left auricle or its appendix, or on atheromatous patches in the aorta The infarcts are wedge-shaped areas in the cortex, usually white or yellow in appear can surrounded by a hæmorrhagic zone, especially ons th they come in contact with the medulla (Fig 82) xy (A t the area is level with the rest of the surface Later on to anced mes depressed, and eventually absorbed, leaving a cic , e g en

Very simila y is usu larly scattered depressed areas are found on the surface so, al e organ which, on section, prove to be areas where these re ex is narrow and fibrosed They are due to interstitial city ci e following blocking of vessels owing to disease Thus s ion when well marked is usually referred to as art in ie lerotic kidney (see p 280).

Microscopic u rance — The infarcted portion shows swelling, granul ty, and more intense staining of the columnar cells of tubules The nuclei usually are broken into masses of chromatin or fail to stain altogether At the margin

found in association with Bright's disease and waxy degeneration.

Naked-eye Appearances —In the first condition there is usually no great alteration in size in the organ   On section, the cortex is pale opaque white in appearance, and contrasts with the more vascular medulla

In the second variety the appearances depend upon the stage of the disease, and will be described in connection with the various types of nephritis and waxy change

Microscopic Appearances —In sections stained by ordinary methods, such as hæmatein and eosin, the cells of the convoluted tubules appear swollen and granular, and their nuclei may show degenerative changes   In sections stained with Sudan III or Scharlach R. the same cells will be found to show numerous *fat granules and globules, more especially in the deeper part of their protoplasm*   In the collecting and other forms of tubules the same change will be found, but less marked

3 *Glycogenous* degeneration occurs in the epithelial cells, especially those of the first part of Henle's loop and of the convoluted tubules in cases of diabetes mellitus   The granules can be brought out by the use of iodine in fresh preparations untreated with water

4 **Waxy (Amyloid).**—This may be found in association with advanced tuberculosis, visceral syphilis, or chronic suppuration, *e g* empyema, bone or joint disease.

The kidney is usually *enlarged*, in the more advanced stages very markedly so, although, when combined with interstitial change, it may be reduced in size   It is *pale* from anæmia and associated fatty change (frontispiece, Fig 6)   As a rule it is *firm*, and shows a sharp edge on section, occasionally it may be soft   The appearances are very similar to those seen in the subacute form of Bright's disease (large white kidney)   In some instances it is possible to distinguish between the two conditions only on testing with iodine   Sometimes the glomeruli can be seen as minute translucent

specks   In the more advanced stages the whole cut surface has a translucent appearance   On treatment with iodine the glomeruli and vessels are brought out as mahogany brown specks and lines   The capsule commonly strips well and leaves a smooth, pale, mottled surface

Microscopically, the change is observed first in the afferent arterioles (see plan, p. 261), it then spreads to the glomeruli and efferent vessels, and also to the middle coat of the larger arteries   The arteriolæ rectæ in the medulla are early affected. In the advanced stages of the disease the basement membrane of the tubules, the periendothelial connective *tissue of the intertubular capillaries, and other strands of supporting fibrous tissue* are implicated.   The waxy material *is homogeneous* and translucent when unstained.   It appears yellow with transmitted, dark brown, with reflected light after treatment with iodine, and gives a rose pink to purple colour, with methyl violet and subsequent differentiation in dilute acid.   There is usually a considerable amount of fatty change, catarrh of the tubules, and, in the later stages, overgrowth of fibrous tissue.

5   *Pigmentary Changes.*— In pernicious anæmia the kidney, like the liver and spleen, may be the seat of the deposit of hæmosiderin   In jaundice the kidney is the first organ to be affected and shows a yellow tinge which becomes green on exposure to the air

6   *Calcification* of the kidney substance is rarely observed in old infarcts and chronic tuberculous lesions   It occurs also in the necrosed kidney epithelium in corrosive sublimate poisoning, but this type is demonstrated only on microscopic examination

7   *Necrosis* is an invariable accompaniment of infarction   It also occurs in minute patches in the epithelial cells in corrosive sublimate and in cantharides poisoning, also in the bacterial intoxications of diphtheria, typhoid, etc., as well as in the auto intoxication of icterus   *Symmetrical necrosis of*

the greater part of the cortex of the kidney is a rare complica
tion of the puerperium due to minute multiple thrombi in
the small interlobular arteries

INFLAMMATION OF THE KIDNEY
OR NEPHRITIS

General Facts —The kidney is an organ essentially con
cerned with the elimination of waste products of metabolism
and poisonous substances   *In any condition in which poisons*
are circulating in the blood, whether these be of chemical
nature or bacterial origin, the organ is apt to be damaged.
Once this damage has occurred and the eliminating function
of the organ interfered with, matters are made worse, for the
irritating poison accumulates, as do also waste products of
metabolism, which further injure the delicate secreting tissue.
Thus a *vicious circle tends to be set up, which intensifies the*
action of the poisonous substance

Amongst these poisons should be placed the following
chemical substances such as alcohol and lead, also bichloride
of mercury, uranium nitrate and chromates   Iodine also has
been found to induce nephritis in animals, and cantharidin is a
well known irritant of the kidney substance   The toxins of
bacteria form a very important group of poisons causing
nephritis   Organic poisons such as snake venom, abrin, and
ricin also are kidney irritants   Poisons arising within the
body itself from no apparent bacterial source may cause
nephritis   For example, in pregnancy toxins may be generated
and give rise to nephritis, and in chronic auto-intoxications, *e g*
gout, the accumulated products of metabolism act detrimentally
on the organ   It is chiefly upon the tubular epithelium, and
more especially on the convoluted tubules, that these poisons
act, although the glomerulus may be damaged in process of
their excretion   On the other hand, some poisons such as
cantharidin and certain snake venoms act more specifically
upon the glomeruli, as do some organisms, *e g* streptococci.

There are two other eliminating channels for waste products
in the body—the lungs and the skin.   These to a certain
small extent are capable of taking on vicariously the function

of the kidney, but only to a very minor extent. Thus in cases of kidney insufficiency the breath and the sweat may contain urea. The converse also holds good, in that when elimination by the skin is interfered with more work is thrown upon the kidney. Thus, on passing from a warm atmosphere where the skin is acting freely into a cold one, there is a sudden change of the excretory responsibility from the one organ to the other. In addition, the internal organs, among them the kidney, tend suddenly to be flooded with more blood, owing to the contraction of the cutaneous vessels. In this way it *is possible to understand the causation of nephritis through chill.* At the same time it must be stated that the general *view is that "chill" acts more as a predisposing cause to* infections.

The kidney is a very vascular organ and one which is specially dependent upon its blood supply for the integrity of its secreting tissue. Thus any localised disease of the vessels of the organ or any general vascular change implicating the renal vessels will tell detrimentally upon its function, and will produce structural changes of the nature of degeneration in the secreting epithelium with subsequent replacement of this by fibrous tissue. Thus, extensive vascular disease is accompanied inevitably by alterations in the kidney. The converse also holds good. When the kidney is damaged, products of metabolism are retained within the circulation which irritate and damage the vessels, leading to thickening and degenerative changes. Thus vascular and renal conditions very frequently coexist, and, inasmuch as the condition of the vessels affects the heart, cardiac disease is eventually super added.

The vascular supply of the organ is peculiar, and it is well to remember this, as it affords a means of understanding how structural changes may follow alterations in blood supply. The renal arches which pass between cortex and medulla give off from their cortical aspect branches known as interlobular, from the medullary aspect come the *arteriolae rectae*, which pass downwards into the medulla. The interlobular arteries give off the afferent arterioles which supply the glomeruli. The blood leaves the glomerulus at the same point as it enters it by the efferent vessels. *The glomerulus is a bag of coiled capillary*

vessels with a narrow neck, through which the blood enters and leaves the structure   But the blood does not at once return to the veins by the efferent channels   The vessel again breaks up into a series of capillaries (see plan), supplying the kidney tubules with blood.   Thus any interference with the flow of blood through the glomerulus will inevitably tell upon the tubules leading to degenerative changes in these   The
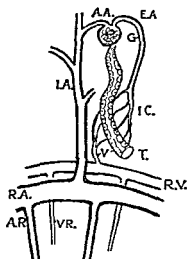
Plan of the Circulation in the Kidney

R A , branch of renal artery I A., interlobular artery, A.A afferent arteriole , G., glomerulus, E.A., efferent arteriole I C., interlobular capillaries T tubule V., venous rootlets , R.V , branch of renal vein, A. arteriæ rectæ , V R., venæ rectæ.

glomerulus and the related tubules dependent for their blood supply upon the integrity of the glomerulus may be looked upon as a structural kidney unit, for which the term "nephron" has been suggested.   If the glomerulus be thrown out of action by the obliteration of its capillaries, degeneration and collapse of the tubules will occur with subsequent replacement of the nephron by fibrous tissue.   Conversely, if the tubules degenerate the glomerulus will cease to function   This is one of the reasons why degenerative and inflammatory kidney con

ditions tend to be patchy in type   As a sequel to this patchy
disappearance of secreting kidney tissue the healthier inter-
vening portions, as is the case in other parenchymatous organs,
tend to undergo hypertrophy and to project on the surface as
rounded nodules between the shrunken areas

A glance at the scheme of vascular supply will show that
the first pronounced narrowing of the kidney vessels is in the
glomerulus.   It is here, therefore, that foreign material such
as thrombi and bacterial emboli tend to be strained off
Without doubt germs play an important rôle in many forms of
nephritis   Their connection with the suppurative forms is
obvious, but even in those instances where no macroscopic
bacterial lesion such as an abscess develops, minute changes
are to be found especially in the glomeruli   Once initiated
these tend to progress and ultimately to involve the other
structures in the nephron

It is equally clear that disease associated with narrowing of the
vessels—arteries or arterioles—will lead to retrograde changes
in the parenchymatous tissue of the organ   If some of the
larger vascular channels such as the interlobular arteries are
affected, the tendency will be to produce large areas of atrophy
with consequent deep depressions on the surface of the organ
similar to those produced by healed infarctions   If the smaller
afferent arterioles of the glomeruli are affected the fibrosed
areas will be much smaller, and their disappearance will lead
to less marked depressions on the surface   All such retro-
grade changes the consequence of arterial disease tend to be
followed by compensatory regenerative changes, just as in
the liver in cirrhosis   It may be contended that such con-
ditions are degenerative, not inflammatory and that therefore
the term nephritis is inapplicable   It is, however, customary
to place fibrous atrophies due to vascular narrowing among the
inflammations, e g as in myocarditis, and there is, of course,
no essential difference in the end result the product being scar
tissue whether the scar follow on inflammation or on a vascular
narrowing

*Causation —*The causes of nephritis thus are —

1 *Chemical poisons,* such as corrosive sublimate, canthi
ridin, lead, alcohol, snake venom, etc , introduced into the

body and excreted by the kidneys, also *poisons formed by the
body itself*, such as abnormal products of metabolism or
normal products present in excess, as in the disease called
gout.

2 *Bacteria and their poisons* in process of excretion, as
in the specific fevers, scarlet fever, typhoid, small pox, etc

3 *Bacteria multiplying locally*, as in suppurative nephritis
and tuberculosis

4 *Circulatory alteration*, acute and chronic congestion and
embolism

Classification —It is customary and convenient to dis-
tinguish two primary groups   (1) *suppurative nephritis*,
where germs are actually present and multiplying in the
kidney, (2) *non suppurative nephritis*, that is to say, where
the germs, although they may be present, are not multiplying
in the organ   Sometimes it is merely the toxins of the
germs which act upon the kidney, the germ focus being in
some other part of the body, at other times the organisms are
in the blood, and damage the kidney while in process of
elimination, at other times again there may be minute emboli
containing germs derived from the heart valves and caught
in the glomerular capillaries   But, at any rate, no macro-
scopic lesion such as an abscess is produced in the non
suppurative form   The foci of inflammatory reaction, if
present at all, are minute   In other cases the disease is due
to poisons, and the changes are therefore more of a degenera
tive than an inflammatory type   This non suppurative type
of nephritis corresponds to what is usually called " Bright's
disease,' after Richard Bright, the London physician who
published his classical work on nephritis in 1827

The present classification of the various forms of Bright's
disease is far from satisfactory   A perusal of any recognised
text book will convince the student of this, and a comparison
of the classifications in the different books will probably
leave him in a hopeless condition of confusion   In the

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author's opinion it will tend to simplification if in the first instance the structural changes met with in the organ in nephritis be considered

There are four chief structures composing the kidney tissue (1) the glomerulus, (2) the tubules, (3) the connective-tissue scaffolding or packing, including the capsule of the organ, (4) the vessels—arteries and arterioles The function of these structures and the alterations which they undergo in this form of disease may now be briefly considered

The glomerulus is a coiled system of capillaries arranged in bunches or lobes, covered with a layer of parenchymatous, secreting epithelium and supported by a small amount of connective tissue, the afferent arteriole enters, and the efferent vessel leaves, at the narrow neck or stalk by which the glomerulus is attached. The function of the glomerulus is, roughly speaking, to filter through its capillary walls and through its covering epithelium a deproteinised blood plasma. This filtration is brought about chiefly by the pressure of the blood. Since that the secretory activity of the epithelial covering is concerned is a debated point. The amount of secretion depends mainly upon the rate of the blood flow, much less upon the pressure of the blood. It has been recently pointed out that all the glomeruli of the organ do not function at the same time. Some districts are active while others rest. This fact may have significance in relation to the frequent patchy distribution of nephritis. From the point of view of the subject under consideration the glomerulus is of primary importance

The tubules are, as their name indicates, convoluted channels lined by a single layer of epithelial cells varying much in size and general appearance placed upon a connective-tissue basement membrane and supported by a small amount of stroma. No details need be entered into regarding the function of the tubular channels, suffice to say that it is, generally speaking, to concentrate the fluid received from the

glomerulus so as to preserve water and certain salts for the
use of the body

The fibrous stroma is, of course, a mere packing around the
parenchymatous elements   The blood supply of the organ
is of primary importance   No secretory nerves have been
demonstrated in the kidney   It is generally assumed, there-
fore, that the control of secretion is dependent upon the
vascular mechanism   Increased determination of blood to
the organ will lead to increased secretion of urine, diminution
in the amount of blood reduces secretion   Passive congestion
of the kidney also leads to diminution in the amount of urine

Pathological Alterations in the Glomerulus in Nephritis

1. *Blocking* of one or more of the lobules of a glomerulus
by a thrombus or an *embolus* sometimes occurs in the more
acute forms of nephritis   In this way a portion of the structure
is thrown out of action   It ceases to pulsate with the
remaining lobules, and becomes adherent to Bowman's
capsule by a process of organisation

2 *Hæmorrhage may occur into the space between Bowman's*
capsule and the tuft   The blood may of course be washed
onwards and appear in the urine, or it may coagulate, forming
a clot which later becomes organised, leading to adhesions
which obliterate more or less completely the glomerular
space

3 *Swelling and proliferation* of the *endothelial cells* lining
the glomerular capillaries is a common change in the early
stages of acute nephritis   It has been observed specially in
"Trench" nephritis by Dunn and McNee

4 *Leucocytic infiltration* of the glomerular tuft and accumu-
lation of leucocytes in the space   This will occur specially
in the acute forms associated with the presence of germs

5 *Proliferation and shedding of the epithelial cells* covering
the tuft and those lining the capsule, or catarrh of the space

in which the tubule takes origin These epithelial cells, in conjunction with connective tissue cells which wander in, lead to the formation of what has been called the " epithelial crescent' A similar result may follow a hæmorrhage into the space, as in (2)

6 *Fibrosis* may occur *within* the tuft as a sequel to (1) or (3), or it may occur *around* the tuft as a result of (2) or (5), or lastly, it may occur *outside Bowman's capsule* as a result of increase in the stroma in that situation All these changes, however, lead to very much the same result, namely fibrous atrophy of the glomerulus

7 Lastly, *degenerative changes* may occur (a) in relation to the walls of the glomerular capillaries, e g hyaline and its specialised form—amyloid, (b) in relation to attached or shed epithelial cells—cloudy swelling and fatty change

The changes met with in the glomerulus are thus mainly of an inflammatory type, and all tend towards the elimination of this structure as a filtering and secreting mechanism One result of this is that in nephritis the blood pressure of the body tends to rise in order that something like the same amount of water shall be excreted by the kidney Just as when some of the pores of a sieve or filter are blocked, a greater amount of pressure must be exerted to force the same quantity of fluid through Further, owing to the damage to the epithelial and endothelial cell elements, these lose their selective capacity, and in consequence permit the passage of the protein substance in the plasma which ought normally to be retained Hence the albuminuria of nephritis Another result of the complete or partial elimination of the glomerulus is that the tubules in connection with it cease to function, and in consequence tend to disappear, the whole "nephron" or glomerulus tubule combination collapsing and being replaced by fibrous tissue This elimination of nephrons may be diffuse or it may be patchy, depending upon the cause of the glomerular damage If, for example, the

damage be due to embolism, as in the nephritis of infective endocarditis, the lesions will be irregularly disseminated and more or less widely separated. On the other hand, if the damage to the glomerulus is due to the excretion of toxins or of individual organisms from the blood, as is probably the case in typhoid and in scarlet fever, the damage to glomeruli will tend to be more or less general. The importance of this patchy or diffuse change is not realised from the morbid anatomical point of view until the condition has reached its "end stage," namely fibrosis with contraction, the general effect being a shrinkage of the cortex of the organ with a roughening of the surface, which will be coarse or fine according as the elimination of nephrons has been patchy or diffuse. The processes of repair and regeneration tend to accentuate this roughening as the more healthy areas of kidney tissue between the scars proliferate, enlarge, and therefore project. From the morbid anatomical point of view the early, more acute glomerular changes may produce little that is visible to the unaided eye. Swollen glomeruli may be visible as clear spots, and hæmorrhage in relation to the tuft will appear as petechiæ. These latter may be very striking. The later stages of glomerular change produce by themselves little that can be seen.

Pathological Alterations in the Tubules in Nephritis

As the tubules are essentially structures composed of parenchymatous cells, the alterations are mainly of a degenerative type, as follows —

1. *Cloudy swelling*, associated with swelling, increased granularity, and loss of nuclear staining. This occurs in all cases of acute intoxication, as, for example, by chemical poison or bacterial toxins.

2. *Fatty degeneration*, commonly a sequel of the above in which, in addition to the other changes, globules of fat like

bodies appear in the protoplasm of the epithelial cells This is characteristic of the more prolonged forms of intoxication, either chemical or organismal

3 *Catarrh* or shedding of the epithelial cells, commonly associated with the above degenerations and accompanied in chronic cases by multiplication of cells

4 *Necrosis* or death of the epithelial cells, in which they lose their structure and staining reactions This is common in the more severe types of poisoning, as by mercuric chloride It also occurs more extensively in some cases of eclampsia

5 *Calcification* occasionally observed as a sequel to necrosis, especially in corrosive sublimate poisoning

6. In prolonged catarrh the *epithelial cells* which remain often *exhibit a lower type*, being cubical or flattened instead of columnar

7 Various forms of *exudate* may occur into *the lumen of the tubules*, e g albuminous or fibrinous material, which forms the basis of the so-called casts, and on which red blood cells, leucocytes, epithelial cells, and crystals may deposit them selves Such casts, if retained, undergo further degenerative changes, tending to become homogeneous and hyaline

8 *Cystic distention of tubules* may occur as the result of hypertrophy and regeneration, or in consequence of obstruction

It should be clearly understood that, as Weigert long ago emphasised, one structure such as the tubules cannot be picked out and attacked without the other structures—glomeruli and stroma—suffering At the same time there are substances (notably the chemical and bacterial poisons) which tend to act selectively upon the tubules, while other factors, chiefly germs, e g those of scarlet fever, yellow fever, etc , appear to attack the glomeruli Damage to the tubules, provided it be not too profound, is much more capable of repair than damage to the glomeruli Hence tubular nephritis occupies a position by itself, the term "nephrosis" having

been recently suggested in order to characterise it The
term, however, is not an entirely happy one, and should be
used with caution

The poison once removed, repair of epithelium follows,
provided always the degenerative changes have not gone too
far Where the damage is mainly tubular the reabsorption
of water and salts is specially interfered with, hence the
resultant polyuria, but it must be remembered that *damage
to the glomerulus also means damage to the tubules* in connection
with it The reverse must not necessarily hold good unless
the damage of epithelium is profound

From the morbid anatomical point of view tubular changes
result in swelling, particularly of the cortex They tend to
produce pallor and friability in the early stages If patchy
the general effect of tubular changes is a mottling from the
presence of opaque, pale, degenerated areas of tubules
alternating with the more translucent and normal In the
later stages, when owing to fibrosis there is obstruction to
tubules, cystic distention tends to occur, particularly, of
course, in the zone immediately subjacent to the capsule

Pathological Alterations in the Stroma

1 *Œdema* or over filling of the tissue spaces with fluid,
leading to separation of the connective tissue fibres

2 *Hæmorrhage* or escape of red blood cells into the stroma

3 *Infiltration* of the connective tissue with cells which may
be (*a*) polymorphs in the more acute infections, (*b*) lympho-
cyte like cells in the subacute and chronic

4 *Hyaline degeneration* of the connective tissue fibres
and basement membranes, as in amyloid disease

5 *Laying down of new connective tissue* with subsequent
contraction and pressure upon glomeruli and tubules, either
following an inflammatory process or as a sequel of the
disappearance of parenchymatous units

The general effect of such changes is, in the earlier and

more acute stages, a separation of the individual kidney elements from one another In consequence, there is swelling of the organ as a whole As soon as contraction of newly formed fibrous tissue asserts itself there will be shrinkage with *narrowing of the kidney substance, of the cortex especially* As the changes become more chronic the consistence of the organ becomes firmer the surface roughens with a finer or coarser appearance according to the diffuseness or otherwise of the fibrosis The general colour will be determined by two factors (1) the amount of blood in the organ depending upon the distention or otherwise of the smaller vessels, (2) the amount of degeneration of parenchymatous cells, the latter change tending *invariably to pallor, especially of the cortex*

This interstitial nephritis in its end or completed form will be much the same whether it has arisen from (1) a primary inflammatory process or (2) by a slow replacement of paren chyma by connective tissue due to some slowly acting poison, or (3) by a similar slow replacement of parenchyma by con nective tissue through malnutrition due to narrowing of blood vessels This similarity in end result has led to a great *degree of confusion between the various forms of fibrous or "cirrhotic' kidney* This matter will be further discussed below

Pathological Alterations in the Vessels in Nephritis

In addition to those changes discussed in connection with the glomerulus, chronic disease of the larger vessels—arterioles and arteries—is a common occurrence in nephritis

The chief changes are (1) *thickening of the media* due to hypertrophy of the muscle in the first instance, later on this is followed by fibrosis, (2) *thickening of the intima,* which may be of the nature of a slow, *fibrous endarteritis obliterans,* or may be of the ordinary degenerative type associated with atheroma All of these changes lead to a narrowing of the vessel lumen The results will be somewhat different accord

ing to the size of the vessel affected and the diffusion of the change It is clear that if a localised narrowing and partial obliteration of lumen occurs in certain of the larger vessels, e g the interlobular arteries, the effect will be practically the same as an infarction Wedge-shaped areas of kidney cortex will slowly disappear, their place being taken by connective tissue Thus a series of deep depressions will form, more or less widely separated from one another by normal kidney On the other hand, if the smaller vessels such as the afferent arterioles of the glomeruli are affected, the result will be much the same as if the glomeruli themselves were destroyed The nephron—glomerulus tubule combination—will be the unit eliminated The fibrosis and consequent contraction will be diffuse, and the surface roughening fine

The matter, however, is not so simple as this, on account of the fact that kidney disease of a chronic type *leads to* sclerosis and narrowing of vessels as well as *results from* it Hence it is a matter of no little difficulty to decide in a given instance which is the primary change—the nephritis or the vascular narrowing Not infrequently, even with a complete clinical history available, any decision is wellnigh impossible

From the morbid anatomical point of view it may there fore be stated that arterial disease leads to fibrosis of the organ with a narrowing of the kidney substance and roughening of surface, which is coarser or finer according as larger or smaller vessels are affected The finer fibrosis is often practically indistinguishable from the end result of a true nephritis involving glomeruli and tubules, except in so far as traces of antecedent inflammatory lesions of glomeruli and degenerative changes in tubules remain, and can be traced microscopically

Theoretically we have, as should be evident from the foregoing discussion, two main bases for classification of the nephritis (1) the basis of the structure affected—glomerulus, tubule, interstitial tissue, vessel, (2) the basis

of the type or stage of the change, i e whether acute,
subacute, or chronic (3) There is still a third basis for
subdivision, and that is the distribution of the change,
whether the condition involves the whole cortical substance
or whether it is scattered in a patchy fashion through the
cortex It must be frankly admitted that from the gross
morbid anatomical point of view the differentiation of these
types is extraordinarily difficult and often impossible

No classification of the more acute forms of nephritis can
be made without the aid of the microscope Further, as
already emphasised no strict division can be made from the
structural point of view, damage to the glomerulus necessarily
meaning tubular change At the same time it is the case that
certain poisons select certain structures for their action As
regards the degree of acuteness or of chronicity, it must also
be acknowledged that no very hard and fast lines can be
drawn, and that the acute passes into the subacute and the
subacute into the chronic by insensible gradations At the
same time, there are certain kidney appearances found in a
nephritis arising rapidly and ending in the acute stage,
certain others which can be confidently expected in a case
lasting months, certain others again which characterise the
cases continuing for years

One word more as regards the use of popular terms such as
" large white," ' small white,' and small red ' kidneys
They may be, as MacCallum says, " deplorable and often
misleading,' but they find favour with the student and the
clinician, and they will undoubtedly remain as useful labels

The classification of all types of nephritis is as follows —

I Non suppurative Nephritis (Bright s disease)
   1 Acute
      (a) Glomerular
      (b) Tubular or catarrhal, often called paren
           chymatous
      (c) Interstitial

2 Subacute (large white kidney)
  (a) Subacute diffuse
  (b) Subacute patchy (the type met with in cases of subacute infective endo carditis, and known as focal embolic nephritis)

3 Chronic interstitial (granular contracted)
  (a) Secondarily contracted (small pale kidney), following on more acute changes
  (b) Primarily contracted (small red kidney), slowly progressive without previous acute stage
  (c) Arteriosclerotic, due primarily to arterial disease

  Amyloid degeneration may occur in connection with 2 (a) or 3 (a)

II Suppurative Nephritis
  1 Embolic or pyæmic
  2 Pyelonephritis (surgical kidney ")

III Specific Nephritis
  1 Tuberculosis
    (a) Embolic (miliary tuberculosis)
    (b) Tuberculous pyelonephritis
  2 Syphilis

Acute Nephritis

The gross appearances in the various forms of acute nephritis are extraordinarily variable and often far from characteristic. In some cases the organ presents very little by way of alteration from the normal. In other instances, especially where the tubules are principally affected, the appearances are merely those of a well marked cloudy swelling. For this type the term 'nephrosis" has been introduced to indicate that degenerative rather than in

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(*c*) *Interstitial Changes* —(1.) Œdema with separation of the connective tissue fibrils from one another (11) hæmorrhage into the stroma, (111.) infiltration of the stroma with polymorphs or lymphocyte-like cells, according to the degree of acuteness

No striking vascular changes are met with at this stage beyond the congestion and hæmorrhage.

Changes in the Urine in Acute Nephritis —The amount secreted is diminished In colour it is often " smoky ' to dark red, owing to admixture with blood On standing it deposits a sediment which contains hyaline and blood tube casts, red blood corpuscles, free epithelial cells, and leucocytes Albumin is usually abundant The total amount of urea excreted is considerably diminished Chlorides are usually reduced in amount

Subacute Nephritis—Large White Kidney

This is a condition which is also often known under the ring names chronic tubular nephritis chronic parenchymatous nephritis, or chronic glomerular nephritis As, however, the changes occupy an intermediate position between the acute and the more pronouncedly chronic, the term subacute is justified The use of the term chronic tends to its fusion with another condition which is quite distinct and to separate, and unquestionably better deserves the term The condition may follow the acute form or it may arise slowly and insidiously The causes are thus the same in the two types Once degenerative changes have begun in the kidney, products of metabolism are retained These, accumulating, act themselves as poisons upon the renal cells Thus a *vicious circle* is established It is *much more difficult for* matters to return to the normal in the case of the kidney once degenerative and inflammatory processes have commenced than it is in the case of any other glandular organ

Naked eye Appearances —The organ is *enlarged*, although the increase in size may not be very pronounced, all stages being met with It is definitely *pale* Hence the term

itself, around it and around Bowman's capsule, but the more advanced hyaline stage with disappearance of cells is absent , (iii) degenerative changes, hyaline and amyloid, may be met with

(*b*) *Tubules* —These again are mainly of a subacute or chronic type   (i) Fatty degeneration one of the main causes of the pallor of the organ, (ii) catarrh and multiplication of the epithelial cells, (iii) the appearance of a flatter type of epithelium, *i e* cubical rather than columnar cells in the convoluted tubules

(*c*) *Interstitial Tissue* — (i) Œdema is a pronounced feature, and one which accounts in some degree for the pallor and increase in size of the organ   (ii) actual increase in the con nective tissue is always present to a greater or less extent This tissue tends to be fairly cellular, showing collections of small round cells here and there   This is occasionally the predominant change   Under these circumstances the term "subacute interstitial nephritis   may be employed to char acterise the condition   The vessels may show a beginning of the thickening which is so prominent a feature of chronic nephritis   This thickening involves both the inner and middle coats   This is not, however, a constant or characteristic change

Amyloid disease is not infrequently associated with subacute nephritis.

Changes in the Urine in Subacute Nephritis —The amount is diminished   The colour is often pale and hazy, but it may be smoky from the presence of blood   The specific gravity is 1010 to 1020   The total amount of urea excreted is reduced   The amount of chlorides varies   A large amount of albumin is present, sometimes up to 3 per cent   Blood may be present   The sediment is usually rather abundant and shows many casts of all varieties, fatty granular, epithelial, sometimes blood and leucocyte casts, also free epithelial cells, red corpuscles, and isolated leucocytes   As the condi tion becomes more chronic the urine tends to show the char acters found in chronic nephritis

Chronic Interstitial Nephritis

This condition may follow one or other of the previous types, or it may arise slowly and insidiously as the result

of the action of some irritant circulating in the blood-stream
Such irritants are alcohol, lead, and products of metabolism
which are not being got rid of, as in gout   There is a *very
intimate relationship between this type of nephritis and arterial
disease*   It is not always possible to decide which condition
is the primary one   Certainly arterial disease may lead to
renal changes such as are found in chronic nephritis, but just
as certainly arterial changes may be the result of renal
inadequacy, products of metabolism not being excreted by
the kidney, and leading to arterial degeneration   Or again,
the two sets of changes may advance *pari passu*, being due
to one and the same cause

The causes of chronic nephritis may thus be summed up —
  1 The condition may follow acute or subacute nephritis,
and the cause may thus be the same
  2 Chronic toxæmias   alcohol, lead, gout
  3 Arterial disease

Inasmuch as the main change in this condition is a fibrosis
or replacement of the kidney tissue by connective tissue, the
term " chronic interstitial nephritis " is generally applicable,
and on account of the appearance of the organ the term
granular contracted kidney " is sometimes used

The essential nature of the process in chronic nephritis,
just as in cirrhosis of the liver, is the degeneration and dis
appearance of the secreting elements, and the replacement
of them by fibrous tissue   This may be brought about by
chronically acting poison, but is not infrequently secondary to
interference with the blood supply   Thus sclerotic changes
in a glomerulus will inevitably lead to interference with the
nutrition of the tubules around which its efferent vessel
breaks up   Similarly endarteritis in the interlobular arteries
will act by causing malnutrition of the area supplied

Naked eye Appearances —The kidney is always *reduced
in size*, sometimes very markedly so   It may be adherent
to the peri renal tissue, and thus present some difficulty in

removal   It is, of course, *lighter* in weight than normal
Instead of the normal 5 ounces it may weigh 3 or even 2 ounces
The *surface is more or less rough*, and usually shows a varying
number of *small cysts under the capsule*   On cutting into it
the organ is found to be *tougher* than usual   The cut surface
presents great variation in colour in different cases, and the
changes are not always uniform, but there are certain funda-
mental alterations which are commonly present   In the first
place *the cortex is narrowed*, more especially the superficial
cortex (Fig 85)   In colour, as already stated, the kidney
varies   In some cases there is no great alteration, in others,
where congestion of vessels is present, the organ is more
intensely red than normal , in other cases, again, where
tubular changes of an acute or subacute type are super-
added to the chronic process the cortex may be pale   Some-
times the colour of the organ in general, and of the cortex in
particular, is employed as a basis of classification , thus the
terms *small red* and *small white* kidney are used   Such terms
are unnecessary   A striking point is that there is not the
usual difference in colour between cortex and medulla, nor is
there the usual line of demarcation   The two seem to pass
into one another   The *larger vessels* at the line of junction
between cortex and medulla *are thickened* and project, and the
lines of the interlobular arteries passing upwards into the cortex
are tortuous   This irregularity in the vessel markings is very
characteristic   There is in many cases an *increase in the fat
around the pelvis* of the kidney   This is due to a shrinkage of
the organ away from the pelvis, the place of the kidney tissue
being taken by the fat   As a result the organ is, if one may
use the expression, smaller than it looks from the outside
The *capsule* of the organ is usually *more or less thickened* and
shows *abnormal attachment* to the surface of the kidney, so
that in stripping that capsule, portions of the kidney tissue
may be removed with it   In other cases this adherence of
the capsule is not marked, but *in all cases the surface of the*

*organ when stripped of the capsule shows more or less irregu
larity* (Fig 86) This roughening may be slight (morocco-
leather appearance) or it may be very marked The sub-
capsular cysts, already mentioned will be obvious on removing
the capsule They contain a clear colourless fluid

Under the above description come at least three distinct
conditions , distinct, that is, as regards their mode of origin

1 **Secondarily Contracted Kidney,** that is one in which
there is a history of previous nephritis It is the end stage of
the disease This kidney is *more often pale* than red owing to
the considerable amount of catarrh and degenerative change in
the tubules Microscopically, it shows evidence of glomeru
litis, *i e* in addition to the fibrosed glomeruli, earlier, more
definitely inflammatory changes are present. The changes
in general are more diffuse than in the second type.

2 **Primary Chronic Interstitial Nephritis** —A condition
with a history of rapidly and suddenly developing serious
renal symptoms in an apparently previously healthy person,
one where the renal changes have been slowly and insidiously
progressing The kidney is *more often red or mottled*
Microscopically, there is a markedly patchy distribution of the
fibrous change alternating with normal or hypertrophied
areas The glomeruli show chiefly the end stage of fibrous
atrophy The tubules show little degenerative change, but
the arteries show marked thickening

3 **Arterio sclerotic Kidney** —There is a considerable
amount of confusion about this type According to some, a fine
form of cirrhosis with minute roughenings of the surface may
be produced by disease of the smaller arterioles The student
would be wise to reserve the term for the kidney showing deep,
irregularly distributed scarrings The organ is *often red*
It may not be greatly reduced in size, but the tendency is for
it to be *more or less shrunken* The *cortical narrowing is
irregular in its distribution,* depending upon the distribution
of the arterial change The arteries are prominent and

thickened   But the most marked changes are the previously
mentioned deep depressions, irregularly scattered and giving
the general impression of old infarctions   Cysts may also
be present, and there may be a finer roughening in addition
to the scars

   Microscopic Appearances — A striking fact on examining
large sections of such kidneys under the microscope is the
variation in the appearances seen in one part from those seen
in another   Areas will be found in which the alterations are
slight, alternating with areas in which they are marked.   In
the early stage of the condition wedge shaped areas of inter
stitial change will be found extending inwards from the cortex.
In the more advanced stages this is exaggerated, areas of
marked fibrosis alternating with areas more or less normal in
appearance   In other cases the interstitial change is diffuse

   (*a*) *Changes in the Tubules* — The epithelium lining the
tubules is cubical rather than columnar, and shows more or
less evidence of catarrhal change   In some cases where an
acute or subacute attack has been superimposed upon the
chronic process the catarrhal changes are marked   Many of
the tubules contain hyaline or colloid casts   In the more
condensed areas the tubules are compressed and narrowed.
In the intervening portions of the cortex the tubules are more
normal in size or, in many instances, dilated, and the cells
lining them are often enlarged   Sometimes dilated tubules
show papillomatous projections into their lumen.

   (*b*) *Changes in the Glomeruli* — These consist in a fibroid
change, all stages of which may be seen   In the earlier stage
the capillaries of the structure are still visible although their
walls are thickened.   In the later stage the glomerulus is
reduced to a knot of fibrous tissue, which may show hyaline
alteration, and often contains no cells.   Again this change
shows irregularity in its distribution.   It is more marked in
the condensed areas, less marked in the intervening portions

   (*c*) *Interstitial Changes* — These consist in an overgrowth
of fibrous tissue.   In the earliest stage this, as a rule, occurs
in wedge shaped areas extending inwards from the capsule.
The fibrous tissue is well formed, although accumulations of
small round cells may occur   The vessels show more or less

obvious alteration As a rule this is most marked in the intima, and consists in a thickening, with narrowing of the lumen At the same time the middle and outer coats tend to be thickened These alterations are seen in vessels of all sizes Sometimes in cases where the organ has a red appearance the intertubular capillaries are dilated.

In the arteriosclerotic type the vascular changes are more marked, otherwise the appearances are very similar

The overgrowth of fibrous tissue occurs round tubules and glomeruli as well as in the neighbourhood of vessels Occasionally the fibrous change occurs diffusely throughout the organ

Changes in the Urine in Chronic Interstitial Nephritis — The amount tends to be increased The urine is pale and has a low specific gravity The amount of urea is diminished As a rule no blood is present and albumin is scanty, sometimes there is merely a trace The centrifugalised deposit shows only occasional tube casts These are chiefly hyaline or granular

Pathological Conditions associated with Nephritis

Cardiac Changes — In acute nephritis degenerative changes may be met with in the heart muscle due to the action of the toxic agent which also causes the nephritis At any stage of the disease pericarditis and endocarditis may occur as complications The most common alteration in the heart, and one that is specially characteristic of the chronic form of nephritis, is hypertrophy of the left ventricle. This is due largely to the associated arterial sclerosis

Arterial Changes — These consist in a thickening of the medium sized and smaller vessels which in the earlier stages is probably due largely to a contraction and thickening of the media, in the later stages to a fibrous transformation of the media and to a thickening of the intima in an atheromatous type The frequent association of chronic interstitial nephritis with atheroma is well illustrated by a series of 144

cases recorded by Lorrain Smith of which 67 6 per cent
showed atheroma of one or more groups of vessels   The
hypertrophy of the left ventricle and the arterial thickening
are both associated with the rise in blood pressure which is so
characteristic of the more chronic types of renal disease
In connection with this it may be noted that in cases of
cerebral hæmorrhage of the variety found in older people some
degree of chronic nephritis as well as arterial disease and hyper-
trophy of the left ventricle may be confidently looked for

Blood Changes —An anæmia of the secondary type occurs
in all cases of subacute and in many cases of chronic nephritis

Lung Changes —Pneumonia and pleurisy are not un
common complications of kidney disease   Œdema is also
common, and is a not infrequent cause of death

Dropsy —Abnormal accumulation of fluid in the lymphatic
spaces and in the serous cavities is very constantly met with
in nephritis, both in its acute and in its subacute manifesta
tions   In chronic interstitial nephritis, so long as the heart
does not fail, œdema is not a prominent feature   The
œdema of nephritis is probably due to a combination of a
number of factors —

(1) Damage to the endothelial lining of the vessel from
the circulation in it of poisonous waste products

(2) A watery condition of the blood, due to the anæmia

(3) Feeble action of the heart

(4) Retention of salt in the tissues

The œdema often shows itself in situations, such as round
the eye, where the tissue is loose, but it may spread and
involve the whole subcutaneous tissue (anasarca), the serous
cavities, and lungs   The œdema of nephritis is relatively
soft to the touch   In the later stages of chronic nephritis a
dropsy having the distribution and character of cardiac
dropsy may appear   It is more connected with the failing
heart than with the kidney condition

Changes in Connection with the Nervous System —In cases

which the with symptoms of uræmia, œdema of the brain is commonly present In all cases albuminuric retinitis should be looked for This shows itself in the form of minute hæmorrhages in the retina As already stated, cerebral hæmorrhage is a frequent cause of death in cases of chronic interstitial nephritis Of the above mentioned series of 144 cases 55 died of cerebral hæmorrhage

Tube Casts

These structures, so characteristic of nephritis in all its stages, are casts of the kidney tubules occurring in these or in the urine In order to examine for their presence the urine should be centrifugalised or allowed to deposit for some hours A little of the sediment is then removed with a pipette and placed on a slide under the microscope In order to see the tube casts properly an ordinary high power lens should be used, and the iris diaphragm of the sub-stage should be shut to a considerable extent The following varieties of tube casts may be distinguished —

(1) *Hyaline Casts* are difficult to see owing to their transparency They may occur in the acute type of nephritis, being formed of an exudation from the blood They form the basis for other types of casts such as the cellular variety In the later subacute or chronic stages transparent casts with a sharper outline are also met with They are often spoken of as *colloid* or *waxy casts* They are due to changes occurring in shed and long retained epithelium

(2) *Cellular Casts* —These may consist of (a) red blood corpuscles, (b) leucocytes, (c) desquamated epithelium, or of a mixture of these They are characteristically present in the acute and subacute stages of the disease

(3) *Fatty Casts* are produced by fatty change occurring in cellular casts of the epithelial type They are most characteristic of subacute nephritis

(4) *Granular Casts* —These are found mainly in subacute and chronic nephritis They are due to changes occurring in cellular casts They may also be produced by the deposit of granules of urates upon hyaline casts

(5) *Crystalline* and *Pigmentary Casts* are occasionally met.

TABLE OF COMPARISON BETWEEN THE VARIOUS TYPES OF BRIGHT'S DISEASE

		Subacute Nephritis or Large White Kidney	Chronic Interstitial Nephritis or Contracted Kidney
		Considerable enlargement.	Reduction in size, often very small.
		Firm	Tough
Appearance of cortex	Varies considerably Often pale as in cloudy swell ing May be congested	Greatly increased in breadth pale and mottled	Always narrowed, colour varies, pale or red
Capsule	Non-adherent.		Thickened and often adherent.
Surface after stripping	Smooth.		Always rough, usually with small cysts
Vessels	Not as a rule altered.		Thickened, cut ends prominent
Perirenal fat.	Not altered		Increased
Associated Conditions.	Œdema of brain, other forms of dropsy, inflammatory conditions, e g pneumonia, pericarditis, etc.		Arteriosclerosis, hypertrophy of left ventricle, cerebral haemorrhage

Suppurative Nephritis

This is a form of nephritis in which germs themselves are present and are multiplying in the kidney tissue It is associated with more or less obvious suppurative foci or abscesses

There are clearly two paths by which bacteria may reach the kidney tissue—the blood stream and the ureter Thus there are two types of suppurative nephritis

1 Hæmatogenous Suppurative Nephritis — Pyæmic or Embolic Abscesses of the Kidney — This tubules is associated with the presence of organisms in the to examine for th pyæmia, ulcerative endocarditis, etc sfugalised or allowed are usually numerous and irregularly so of the sediment is kidneys Occasionally the abscesses need on a slide under or even one group, and the condition is the cast properly organ The germs found are those associated and pyæmia and ulcerative endocarditis (see pp 97 and 68)

Naked-eye Appearances — The organ may be slightly enlarged, and is somewhat softer than normal On section, opaque yellow foci are found scattered through cortex and medulla quite irregularly or in groups (Fig 87) These foci vary in size, but are usually minute, and are surrounded by a zone of congestion and hæmorrhage The intervening portions of cortical substance are pale The capsule strips well and the abscesses are often particularly well seen (Fig 88) from the outer aspect Infarcts are not infrequently associated

Microscopic Appearances — All the appearances of an acute nephritis are present. There is marked cloudy swelling and catarrhal change in the tubules, and, in the neighbourhood of suppurative foci, actual necrosis The most striking change however, is an acute interstitial change, the fibrous structures being infiltrated with numbers of cells, chiefly polymorpho-nuclear leucocytes This change is intensified in parts so

that the kidney tissue disappears, and its place is taken by a
mass of leucocytes—in other words, there is an abscess.   In
the centre of this area masses of germs are not infrequently
found, and around the mass of leucocytes a zone of hæmorrhage
occurs   The vessels generally are congested   Leucocytes
may also be found within the lumen of tubules

2 *Suppurative Pyelonephritis or Surgical Kidney*—In
this type the infective agent arrives by way of the ureter
It is thus associated with inflammation of the bladder,
ureter, and pelvis of the kidney   It is usually bilateral, but
is often more marked on one side than on the other   It
may occur in cases of cystitis due to infection by the passing
of a catheter   It is thus found in connection with obstruc
tion to the urinary passages from stricture or enlarged
prostate   It not infrequently follows lesions of the spinal
cord where there is loss of control of the bladder and the urine
dribbles away   Organisms readily pass up the tract under
these conditions and infect first the bladder, then the ureter,
the pelvis of the kidney, and kidney itself   The organisms
found are very frequently inhabitants of the lower bowel,
thus *B coli* is very commonly present, also *streptococci,
staphylococci*, etc

Naked eye Appearances—The organ is often enlarged,
soft, and pale   It may, however, be abnormally small from
pre-existing chronic nephritis   On section, *pus is found in
the pelvis*, which may show thickening, injection of vessels,
fibrinous exudation, or hæmorrhage, but which frequently
shows no very obvious alteration   Running up into the
medulla are *yellow lines* representing spread of the sup-
purative process into the pyramids   In the cortex are
similar but more rounded areas (abscesses) with a zone of
hæmorrhage surrounding them   The intervening portions
of cortex are pale   The capsule may or may not strip easily
according as chronic interstitial changes are present or not.
The abscesses are often well seen from the outer surface

Microscopically, the changes are precisely similar to those found in the previous type

Tuberculosis of the Kidney

Two types of tuberculosis of the kidney may be distinguished

1   A type *associated with blood infection,* and therefore with miliary tuberculosis of other organs   In this type there are small, scattered white or yellow foci, usually minute, and mainly in the cortex

Microscopically, these are found to be typical tubercle follicles with giant cells or caseous centres (see p. 174)

2   *Tuberculous Pyelonephritis* or *Chronic Tuberculosis*—This type may be associated with tuberculosis of the lung or other organs   Not infrequently, however, the lesions, in the renal tract, are the most striking manifestation of the disease   The condition of the kidney is very frequently associated with tuberculosis in other parts of the uro-genital tract, with tuberculosis of testicle, vesiculæ seminales, vas deferens, bladder, and ureter   Undoubtedly in some cases the infection is an ascending one, but in many cases the bladder may be infected from the kidney

Naked eye Appearances—The appearances vary much according to the stage of the disease   The condition may be limited to one kidney, in most cases it is more advanced in one organ than in the other   The organ may be enlarged and is usually pale   The change begins in the pelvis in most cases, and spreads backwards into the substance of the organ   The pelvis is thus *lined with caseous necrotic material,* and scattered through the kidney substance are fibro-caseous foci (Fig 89)   Destruction of the kidney substance proceeds with the formation of cavities or excavations (Fig 90)   In advanced cases the organ may be transformed into a bag containing structureless caseous material

The condition is sometimes, in its more acute manifestations, difficult to distinguish from suppurative nephritis   The foci in tuberculosis tend, however, to be firmer, more yellow, and to stand out more from the surrounding kidney tissue

Microscopically, the changes are those usually associated with the more chronic types of tuberculosis—fibrosis, tubercle follicles and caseous foci.

Syphilis of the Kidney —In some cases of syphilis a *diffuse interstitial nephritis* may be met with   This may or may not be combined with amyloid disease   *Gummata* of the kidney occasionally occur

Leukæmia of the Kidney —In some cases of leukæmia the kidney undergoes little or no alteration   In other cases, more especially in the lymphatic type, the changes may be extreme

In a well marked case of leukæmia kidney the organ is *enlarged* and *pale* (one type of large white kidney) and through it and under its capsule are scattered *numerous hæmorrhages*   The characteristic appearance of the cut surface of the organ is to a great extent lost

Microscopically, there is a marked infiltration of the organ with round cells, lymphocytes, or myelocytes, as the case may be, with a separation of the kidney structures—glomeruli and tubules—from one another   Areas of infiltration with red blood corpuscles are also met with.

Tumours

Simple tumours are infrequent, with the exception of small fibromata of the medulla of the kidney, which are very common and appear as small white rounded areas   Adenomata occasionally occur

Of *malignant growths* sarcomata are more common than cancers   They are specially frequent in children, and are often of a mixed type containing glandular elements and sometimes striated muscle, cartilage, etc   Such growths are teratoid in nature and are known as blastocytomas

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Rhabdomyomata or striped muscle tumours of sarcomatous nature are occasionally met with

Hypernephromata are among the commonest type of kidney growth   They are believed by some to arise from suprarenal rests Such rests are not infrequently found under the capsule of the kidney as small yellow spots.   More often they arise from the kidney itself   The hypernephroma varies very much in size and appearance   It usually has opaque yellow areas suggesting the cortex of the suprarenal in appearance, mixed often with hæmorrhagic areas and brownish areas of necrosis (Fig 92)   The tumour is undoubtedly simple in many cases, but in others, where it attains a very large size, it shows malignant characters, and often gives rise to secondary deposits in lungs, bones, and other tissues   Tumours with similar appearances are found arising occasionally in suprarenals, liver, and pancreas

Microscopically, the appearances of the hypernephroma vary a good deal, but, as a rule, the cells contain a large amount of fat, myelin, etc, are vacuolated, and generally show some approximation to the appearance of the cells in the cortex of the suprarenal

METHOD OF EXAMINING A KIDNEY REMOVED FROM THE BODY

Having removed all adherent fat which, except in cases of chronic interstitial nephritis, is easily done, note, in the first instance, the size of the organ and its weight.   The normal kidney measures about 4½ inches (11 12 cm) in length, 2 inches (5 6 cm) in breadth, and 1½ inches (3 4 cm) in thickness   The average weight is 5¼ ounces (150 gm)   Next examine the surface for any gross irregularities, yellow areas under capsule indicating suprarenal rests and cysts or cicatrices   Holding the organ in the left hand, with the hilum towards the palm, cut it longitudinally with a large knife from its convexity to the pelvis, taking care not to injure the glove or the hand which is holding the organ (see Fig 13)   While cutting, note the consistence of the kidney tissue.   Examine the cut surface, attending to the following points —

(1) The cortex, its breadth relative to that of the medulla. This should be as one to three, the cortex measuring about

one fifth of an inch (5 6 mm) in width   Its colour which
should be reddish brown, somewhat paler than the medulla   The
lines of the vessels running through it for any tortuosity or un
usual distinctness from congestion   The glomeruli for unusual
prominence and alteration of colour on treatment with iodine.

(2) The line between cortex and medulla, which should be
fairly distinct, forming a series of arches   In cases of inter
stitial nephritis this line is indistinct and irregular   Note also
the appearance of the larger vessels (renal arches) running
between cortex and medulla.

(3) The medulla for its colour, any opaque lines indicating de-
posits of urates the presence of small grey nodules—fibromata.

(4) The pelvis for thickening, hæmorrhage, calculus or
exudate indicating inflammation.

(5) The peripelvic fat for its relative amount.   In the
normal organ there is only a very small amount of this   In
chronic interstitial nephritis, on the other hand where there
has been a more or less marked shrinkage of the organ, it is
often greatly increased

(6) With a pair of dissecting forceps take hold of the
capsule of the organ, ensuring that the whole capsule is grasped
by crushing through a small portion of the most superficial
cortex with the instrument   Strip the capsule from the cortex,
noting the relative ease with which this is done, i e whether
portions of cortex are removed along with the capsule.   Then
note the appearance of the outer surface of the organ, whether
it is smooth or rough   If rough, whether the roughness is
uniform or irregular   Look for subcapsular cysts, cicatrices
indicating old infarcts or the more regular markings of fœtal
lobulation   Note lastly the thickness of the capsule

DISEASES OF THE PELVIS OF THE KIDNEY

Hydronephrosis, or dilatation of the pelvis of the kidney,
is due to obstruction to the outflow of the urine   The
condition may be bilateral or unilateral

(1) *Bilateral hydronephrosis* is due, as a rule, to some
obstruction to the passage of urine through the urethra,
e g stricture, enlarged prostate, calculus in the bladder.

Occasionally it is produced by a large tumour in the pelvis pressing upon both ureters. The ureters in this type are dilated throughout as well as the pelves

(2) *Unilateral hydronephrosis* is due to some obstruction to the flow of urine through one of the ureters. This may be (a) something blocking the lumen of the ureter, usually a calculus, (b) kinking of the ureter from cicatricial changes following injury, with the formation often of one or more S-shaped bends (Fig 91), (c) a tumour pressing upon the ureter from the outside

As the result of the increased pressure within the pelvis, the calyces become distended and the pyramids flattened Gradually the pressure causes atrophy of the kidney substance, until eventually it may disappear altogether, leaving a fibrous bag containing a fluid which shows only traces of urea and urinary salts. This distention occurs only if *the obstruction is incomplete*. Complete obstruction to the outflow of urine leads, not to hydronephrosis, but to atrophy of the kidney.

Pyonephrosis is a precisely similar condition to the preceding, in which the fluid in the dilated pelvis is pus. Infection may occur from the bladder or by way of the blood

Pyelitis, or inflammation of the pelvis of the kidney, may be associated with the irritation due to the presence of a calculus. More often it is caused by an organism such as *B coli* or one of the pyogenic cocci. Occasionally it may be due to the presence of animal parasites such as filariae. In the organismal type, infection may come from the bladder or from the kidney

In many cases there is very little alteration. In well-marked cases there is congestion of the vessels, minute haemorrhages and exudate

The inflammatory process tends to spread to the kidney itself, giving rise to suppurative pyelonephritis (surgical kidney).

Turbid fluid in the pelvis of the kidney should be examined microscopically in doubtful cases, as phosphates in the urine give an appearance very similar to that of pus.

DISEASES OF THE URINARY BLADDER

Dilatation is due to obstruction or to paralysis of the muscular wall   It may be uniform or localised to certain points with the consequent formation of *diverticula*

Hypertrophy of the muscular wall of the organ is due to obstruction to the outlet of urine   This may be caused by enlarged prostate, tumour, calculus, stricture of the urethra, or phimosis   The thickening often occurs irregularly with the formation of bands or trabeculæ   The bladder, in addition to being hypertrophied, is usually also dilated, either uniformly or with the formation of diverticula

Rupture may be due to falls or severe blows when the viscus is distended with urine.   The rupture usually takes place on the anterior surface and at the trigone   It is followed by extravasation of urine into the peritoneum or into the cellular tissue, and in the latter case by cellulitis and gangrene

Perforation of the bladder may be due to ulceration sometimes caused by *calculus* or by *malignancy*, or to the passage of an instrument   The opening usually takes place into the peritoneal cavity

Hæmaturia.—The appearance of blood in the urine may be due to nephritis of an acute or subacute type, pyelitis, cystitis, calculus in some part of the urinary tract, tumour of the kidney, pelvis, or bladder, rupture or injury of the bladder,

renal tuberculosis, infarction, animal parasitic conditions such as bilharziosis and malaria, or to some unknown cause as in essential hæmaturia

Inflammation (*Cystitis*) —Organisms may reach the bladder (1) from the blood, often by way of the kidney, or (2) from without by the urethra   The latter is the commoner path of infection, the organisms being introduced by means of a catheter or finding their own way up in cases where there is incontinence of urine   The commonest germ found in cases of cystitis is *B coli*, but *B proteus* and cocci of various types are met with   Cystitis may also be associated with inflammation in neighbouring organs, such as the rectum   A degree of inflammation is usually present along with calculi, but the calculus may be a sequel of cystitis

In slight degrees of the disease there may be merely an increased vascularity of the mucous membrane of the organ, often with minute hæmorrhages   In more severe types there is ulceration and in some cases necrosis of the mucous membrane with slough formation

The urine in cystitis may be acid when voided, but it tends rapidly to become alkaline   In some cases this change occurs within the bladder   There is usually a copious deposit consisting, in addition to phosphates, of transitional epithelial cells from the bladder wall, pus cells, and micro-organisms

Tuberculosis of the bladder is usually associated with tuberculosis of the kidney   It appears first as small tubercles under the mucous membrane   These are found either grouped thickly round the orifices of the ureters (descending infection) or at the trigone and neck of the bladder (ascending infection)   Later, ulceration occurs, due to coalescence of the small tubercles and destruction of the mucous membrane   As in other types of bladder ulceration, urinary salts are frequently deposited upon the floor of the ulcer

Tumours.—The common tumours of the bladder are the *villous papilloma* and the *carcinoma*

The former occurs as a soft, friable, " sea anemone " like outgrowth, usually from the base of the bladder Filaments from the growth not infrequently break away and are found along with isolated epithelial cells in the urine Hæmorrhage is very common in such cases Very frequently these papillomata are multiple

Carcinoma of the bladder is usually of the squamous epithelioma type It appears as an ulcerated area with raised hard margins

Calculi in the Urinary Tract —These are found in the pelvis of the kidney or in the bladder, also occasionally in process of passing down the ureter or urethra Stones which originate in the pelvis of the kidney may in this way be found in the bladder Urinary calculi are rarely found in the post mortem room They are usually solitary, but may attain a very large size and may show branching as in the so-called " coralline " calculus of the kidney (Fig 93)

Those which form in the pelvis of the kidney are usually composed of uric acid, urates or oxalate of lime, or a combina tion of these with phosphates Those which arise in the bladder are usually composed of phosphates

By blocking the pelvis of the kidney, calculi not infrequently cause hydronephrosis The presence of a stone in the bladder leads to hypertrophy of the wall of the viscus and to a degree of cystitis.

Parasites —*Bilharzia hæmatobium* is sometimes found in the bladder The adult worms occur in the vesical veins The ova, which show a characteristic terminal spine, are found in the submucosa, where they cause thickenings and papular elevations They also occur in the urine along with red blood corpuscles.

CHAPTER XI

DISEASES OF THE BRAIN AND SPINAL CORD AND THEIR MEMBRANES

DISEASES OF THE MEMBRANES OF THE BRAIN

THE dura mater forms an inner lining to the cranial bones and it carries the meningeal arteries and veins In consequence of this, inflammatory conditions of the bones and of the cavities which they enclose such as the middle ear, ethmoidal and sphenoidal sinuses, are apt to involve the dura and to cause thrombus formation in veins such as the lateral sinus, which come into intimate contact with them

In young children the dura mater adheres more closely to the cranial bones than it does in the adult

Hæmorrhage.—Bleeding may take place between the bones of the skull and dura mater (extradural hæmorrhage), into the dura mater itself (such are infrequent and small owing to the density of the membrane), or between the dura and the pia arachnoid (subdural hæmorrhage)

An *extradural hæmorrhage* may be of considerable size, and may exert pressure upon the subjacent brain It is caused by injuries to the head and is associated with fracture of the bones of the skull, the blood coming from one of the meningeal vessels, often from the middle meningeal artery

Subdural hæmorrhage may be due to injury of the vessels of the dura mater or of the pia arachnoid It may also be caused by the rupture of a diseased vessel, or of an aneurysm on a vessel at the base of the brain Sometimes it is due to a hæmorrhage into the substance of the brain or into the ventricles finding its way to the surface Occasionally it is due to inflammation of the meninges, either of the dura mater (pachymeningitis hæmorrhagica, see below) or of the pia mater in very acute inflammation, as anthrax

Thrombosis —This is not an uncommon occurrence in the venous sinuses of the dura mater   It may be due to wasting diseases such as marasmus in infants, or it may be due to infection   The commonest cause is spread of inflammation from the cavities in the bones at the base of the skull, particularly the middle ear and the mastoid antrum   Such thrombi must be carefully distinguished from post mortem clots (see p 67)   Occasionally the thrombi undergo septic softening owing to invasion by germs, with consequent pyæmia and metastatic abscesses in the lungs   This is specially common in those forming in relation to disease of the middle ear and mastoid antrum

INFLAMMATION OF THE MEMBRANES OF THE BRAIN (MENINGITIS)

TYPES

   1 Pachymeningitis.

      (1) Acute

      (2) Chronic.

      (3) Pachymeningitis hæmorrhagica

   2 Leptomeningitis

      (1) Acute, due to various pyogenic organisms

      (2) Tuberculous

      (3) Syphilitic

      (4) Serous

Two main types of this may be distinguished, although the two very frequently occur together   (1) Pachymeningitis, or inflammation of the dura mater.   (2) Leptomeningitis, or inflammation of the pia arachnoid

   1 Pachymeningitis, or inflammation of the dura mater, is usually secondary to suppurative inflammation in one of the cavities in the bone, such as middle ear and mastoid disease, or to a penetrating wound of the skull   It may be accompanied by septic thrombosis in the venous sinuses in the neighbourhood of the inflammatory focus, or by abscess of the brain

or leptomeningitis. The membrane is somewhat swollen, the vessels are injected, and there is exudate on the surface The pia arachnoid may adhere to the affected area

Chronic pachymeningitis may occur in connection with fractures or with chronic bone disease

A rare condition known as *pachymeningitis hæmorrhagica* is sometimes found in cases of insanity, such as general paralysis and senile dementia and in alcoholism and scurvy On the inner aspect of the dura mater which covers the vertex, as a rule close to the *falx cerebri,* laminated blood clot is found Some regard the condition as being merely a hæmorrhage due to rupture of a degenerated vessel, others consider it to be inflammatory Under the latter supposition the primary change is believed to be a fibrinous exudate on the surface of the membrane This becomes organised Some of the young blood vessels in this granulation tissue give way from time to time and so layer upon layer of blood clot is formed Those who hold the view that the condition is purely hæmorrhage see in the granulation tissue merely an attempt to organise the blood clot

2 **Leptomeningitis,** *or inflammation of the pia arachnoid* —This may be due to—

(1) Infection passing from a *fracture or a penetrating wound of the skull or from a fracture of the base* by way of the ear or nose

(2) *Spread of inflammation through the bone* from a suppurative focus in middle ear, mastoid antrum, or other space

(3) *Infection from the Blood*—In cases where organisms are circulating in the blood the germs may settle down in the membranes of the brain, because for some reason these form a favourable site for their growth

As regards the organisms found   inasmuch as *pneumococci* in children and *streptococci* in adults are common causes of middle ear disease, such germs are very frequently

found either by themselves or in combination with others
Staphylococci and *B pyocyaneus* occasionally occur *B in-
fluenzæ* may be met with sometimes as a bacillus or in the form
of filaments The *Diplococcus intracellularis meningitidis* is
found in cases of epidemic cerebro-spinal meningitis (spotted
fever) *B tuberculosis* is responsible for a large number of
cases Rarer organisms are *B anthracis* and *Streptothrix
actinomyces* In tuberculous meningitis, and, more rarely,
in other forms, infection may be due to spread from diseased
vertebræ

Naked eye Appearances —There is *congestion of the menin
geal vessels*, and vessels normally invisible can be seen In
some cases of rapidly fatal cerebro-spinal meningitis this is
all that can be noted After one or two days there is usually
more or less exudate This exudate may be fibrinous or puru
lent It may be very obvious, yellow and creamy, or thin
and inconspicuous It tends to accumulate in the spaces
between arachnoid and pia (Fig 94), more especially in the
interpeduncular space and in the sulci along the lines of the
vessels The *distribution* of the change varies in different
types In most types, notably in cerebro-spinal meningitis
and in the tuberculous type, the condition is most marked
at the base, the exudate occurring in the interpeduncular
space and *spreading up on either side along the Sylvian*
fissure, also on to the surface of pons, cerebellum and occipital
lobes In other case the change is most marked on the
vertex or over the frontal lobes (pneumococcal cases) The
convolutions tend to be *flattened* There is usually an *excess
of cerebro-spinal fluid*, which is turbid and may be purulent
The inflammatory change may extend to the ventricles,
and in many cases these spaces show more or less distention
with fluid (hydrocephalus)

The membranes of the spinal cord are very constantly
affected to a greater or less extent When this is the case
the term *cerebro spinal meningitis* may be applied

Microscopic Appearances —These are similar to those found in inflammations of other serous surfaces   There is dilatation of blood vessels, exudation of fibrinous material on the surface and in the substance of the membranes, and emigration of leucocytes, chiefly of the polymorphonuclear type.   Organisms may be found in suitably stained specimens.   There is usually *more or less inflammation of the underlying cerebral substance* (encephalitis) as indicated by cellular infiltration around vessels dipping into the brain substance

Microscopic examination of the cerebro-spinal fluid obtained during life by lumbar puncture shows polymorphonuclear leucocytes in greater or less abundance, and sometimes germs.

Tuberculous meningitis requires special mention.

It is essentially a basal inflammation and is usually associated with a similar inflammation of the spinal meninges   A more or less marked increase of cerebro-spinal fluid is found, which is often fairly clear   In the sub arachnoid space at the base of the brain and spreading up the sylvian fissures there may be an opalescent exudate   Sometimes it is conspicuous and creamy, at other times it is difficult to make out at all   The smaller vessels appear thickened, owing to perivascular infiltration, and at the spreading margin, along the vessels of the Sylvian fissure, or upper surface of cerebellum, etc., *minute grey or yellow tubercles* are found (Fig 95)   Sometimes these are only discovered on stripping the membranes and examining them most carefully by floating them out in water   The ventricles are more or less distended with fluid which may be clear or slightly turbid

Microscopic Appearances —The cells in the exudate tend to be of the mononuclear type, but in the more acute cases polymorphs are often abundant   Here and there especially round vessels, are follicular aggregations of cells with giant cells or necrotic centres.   Tubercle bacilli may be numerous, but are often difficult to find

Microscopic examination of the fluid obtained by lumbar puncture shows cells which tend to be of a mononuclear type,

but polymorphs are not infrequently present in considerable numbers On careful search tubercle bacilli are generally to be found, but it is necessary, in most cases, to centrifugalise the fluid, and to make several films from the deposit.

Syphilitic Meningitis —This may be acute associated with an infiltration of the pia-arachnoid with small round cells It may be accompanied by gummata in the shape of small foci with yellow caseous centres which show a tendency to infiltrate the brain substance Or it may be chronic, associated with fibrous thickening at the base of the brain and leading to compression of the cranial nerves

Serous meningitis is a condition comparatively recently recognised which is characterised by congestion and œdema of the meninges with production of a serous and cellular exudate It is most frequently found in children and is associated with infective diseases, e g measles and scarlet fever , in adults it is sometimes found in relation to alcoholism and kidney disease The appearances are sometimes more marked at the base of the brain, sometimes at the convexity. The causal factor is not always clear

DISEASES OF THE BRAIN

CIRCULATORY CHANGES

1 Congestion of the cerebral vessels may be due to active hyperæmia in inflammations such as lepto-meningitis or to chronic venous congestion, the result of valvular disease of the heart

2 Anæmia may be part of a general want of blood, as in pernicious or other type of anæmia or severe hæmorrhage, or it may be local, due to accumulation of blood elsewhere or to the pressure of a tumour

3 Œdema is a common condition which may occur as part of a more general dropsy or may be localised to the

cerebral substance The causes are those of œdema in general, such as renal and heart disease Alcoholism is a not uncommon cause Chronic alcoholics not infrequently die, apparently from this cause alone Clinically such cases may simulate, as regards their symptoms, many different types of cerebral lesion,—hæmorrhage, thrombosis, etc—and at the post mortem the only brain condition found is œdema.

On section the brain in œdema has a *moist shiny appearance* The grey matter is often rather more obvious than usual from congestion of minute vessels A small amount of fluid may be squeezed from the cerebral substance, and the ventricles are usually distended with fluid

4 **Hydrocephalus**, or excess of fluid in the lateral ventricles, may be *congenital* or *acquired*

In the *congenital* form the head may attain an enormous size The cranial bones are thinned and separated from one another There is great distention of the lateral ventricles and narrowing of the cerebral substance The large size of the head leads to difficulty at parturition The cause of the condition is obscure, but it is probably mainly due to obstruction to the outflow of fluid from the ventricles into the meningeal spaces

Acquired hydrocephalus follows sometimes from basal meningitis or tumour formation at the base of the brain It is due to the matting of the meninges and consequent obstruction to lymph flow, following on the inflammatory condition (Fig 96), or to direct pressure of the neoplasm on the vessels.

Excess of cerebro-spinal fluid in subdural and subarachnoid spaces is met with in a large variety of diseases It may occur as part of a general œdema, it may be due to inflammation of the meninges, or may accompany atrophy of the cerebral substance in chronic alcoholism and in various forms of mental disease.

5 **Arterial Obstruction.** — This may be due either to *thrombosis* or *embolism* *Thrombosis* is usually secondary to disease of the arterial wall, either atheroma or syphilitic disease (endarteritis obliterans) It also occurs secondary to embolism It is met with more commonly in the branches of the posterior cerebral and basilar arteries and in the small superficial cortical branches *Embolism* is brought about by the impaction of an embolus, usually a portion of a thrombus, in a vessel the lumen of which is too small for its passage The portion of thrombus may come from (1) a vegetation on the mitral or aortic valve , (2) a thrombus in the auricle or ventricle , (3) a thrombus on a patch of atheroma in the ascending aorta , or (4) from a thrombus in an aneurysm of the ascending aorta or aortic arch (see diagram, p 66) The arteries at the base of the brain are specially apt to be involved The commonest vessel to be blocked, because it offers the most direct route for the embolus, is the middle cerebral (usually the left) or its branches Then, in order of frequency, come the posterior cerebral, the vertebral, the anterior cerebral, the cerebellar and basilar As a result of the presence of the embolus blocking the vessel, thrombosis occurs to a varying extent

Results of Arterial Obstruction — The cerebral arteries, more especially those branches going to the ganglia at the base of the brain, belong to the group of ' end arteries,' *i e* arteries whose collateral anastomosis is not equal to the re-establishment of the circulation after blocking of the vessel Infarction therefore occurs, and the type of infarct which develops is the pale infarct The reason for this is that, owing to swelling of the nerve elements in the primary stages of degeneration, the return of blood by way of minute collaterals cannot occur or occurs only to a very small extent In contrast to other organs such as kidney and spleen, where pale infarcts also occur, the necrotic change which takes place results in progressive softening (colliquative necrosis),

instead of, as in kidney and spleen, coagulation necrosis
Such a pale, softened area is often called an area of *white
softening* Sometimes there is a certain amount of return of
blood which escapes from the degenerating vessels with
resulting numerous small hæmorrhages (*red softening*) Later
on, as liquefaction proceeds and changes occur in the blood
pigment, the area tends to become yellow (yellow softening)
Ultimately, removal of the degenerated material occurs with
the formation of a cyst, the walls and sometimes the contents
of which show yellow pigmentation (Fig 98)

In the later stages such areas are, of course, easily recognised
Sometimes, when death occurs rapidly owing to the area
involved being large or including some vital centre, the recogni
tion is somewhat difficult There may be nothing more than
a very slight softening of the cerebral substance Thus *in
all cases where arterial obstruction is suspected the consistence
of the brain substance should be estimated by careful palpation*,
suspected areas being compared as regards their consistence
with the corresponding areas on the other side as well as with
surrounding parts of the brain

Microscopic Appearances —These are the changes usually
found in degenerations of the central nervous system —

Ganglion cells show loss of staining of their Nissl bodies
and nuclei The nucleus loses its central position and is eventu
ally extruded The cell processes become fragmented

Myelin substance absorbs water, swells and breaks up into
fatty material, which may be demonstrated by fat stains,
cholesterin, lecithin etc The fat globules are taken up to a
certain extent by phagocytes, thus forming granular looking
cells sometimes called compound granular corpuscles.

In the later stages the *neuroglia and other connective
tissue elements* proliferate, the young mononuclear cells which
are thus produced acting as phagocytes for fat, blood corpuscles
and blood pigment The area is invaded by leucocytes, mainly
mononuclear, which also act as phagocytes Hæmatoidin
crystals are often found at the margin of the area, also in the
fluid contents of the cysts.

6. Cerebral Hæmorrhage —Although capable of con
siderable resistance to strain, the arteries of the brain are
much thinner walled than those of any other organ or part.
More especially are they deficient as regards muscular sub-
stance   Moreover, they are less well supported owing to
the relative softness of the brain substance   For these
reasons, rupture of vessels and consequent hæmorrhage is
more common in the brain than in any other organ

There are *two main factors* operative in cerebral hæmor-
rhage —(1) *degenerative changes in the vessel wall* , (2) *increased
blood pressure*   As regards the *degenerative changes,* these
may be relatively acute as in the vessels of an infarcted area
or in the inflammation following septic embolism (*e g*   in
ulcerative endocarditis), or slowly progressive as in atheroma
or syphilitic disease   Not infrequently the vessel, previous
to rupture, undergoes localised dilatation with the formation
of an aneurysm   *Increased blood pressure* is either sudden
from strain, or chronic, as met with in cases of generalised
thickening of the vessels and in kidney disease, which is so
frequently accompanied by chronic vascular disease   Thus
the two factors often occur together, and *in all cases of
cerebral hæmorrhage careful examination of the vascular
system and of the kidneys should be made*

Types

1   Small capillary (petechual) hæmorrhages

2   Large hæmorrhages which may be into

   (a) Basal ganglia sometimes extending into the
       lateral ventricle

   (b) Pons Varolii

   (c) Pia arachnoid on cerebral cortex.

   (d) Cerebellum

   (e) Other parts of the brain.

3   Hæmorrhage due to laceration of brain

As regards *hæmorrhage caused by disease,* one may dis-
tinguish, (1) *small capillary hæmorrhages,* which are found in

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acute inflammation of the cerebral substance, infective diseases, cerebral softenings, blood diseases such as purpura and pernicious anæmia, or in tumours, (2) *large, extensive hæmorrhages*, which are usually due to chronic disease of the vessels, much less frequently due to septic embolism in cases of acute (usually ulcerative) endocarditis, and may occasionally be due to rupture of a vessel in a tumour such as a glioma The first type of cause is met with most commonly in individuals past the prime of life, the second and third types may be met with at any age It is stated that in something like one third to a half of the cases of the first type the point of actual rupture is a small aneurysm Some of these aneurysms, more especially those in the vessels at the base of the brain, are easily visible with the naked-eye Others, which are usually in connection with the more minute vessels inside the cerebral substance, are only visible under a low power of the microscope Such aneurysms have been called miliary Some of these miliary aneurysms are in reality false aneurysms

The most common *site* for cerebral hæmorrhage is the *region of the basal ganglia* (Fig 97) Something like 75 per cent of cases occur in this position The vessel which ruptures is usually the lenticulo-striate branch of the middle cerebral artery, which supplies the outer segment of the lenticular nucleus and the external capsule It then perforates the internal capsule and ends in the caudate nucleus So frequently is this vessel the site of origin of the hæmorrhage that it has been called the artery of cerebral hæmorrhage

The next most frequent site for hæmorrhage is the *pons Varolii* (12 per cent) (Fig 100) In something like 12 per cent the hæmorrhage commences in one of the *superficial vessels, i e* one of the cerebral arteries which has not yet penetrated the brain substance A rare situation for hæmorrhage is the *cerebellum* and other parts of the cerebrum, such as the frontal lobe When the cause of the hæmorrhage

is a septic embolus or one of the hæmorrhagic diseases such as purpura, the site may be almost anywhere, *e g* the frontal lobe   In the case of a hæmorrhage into the basal ganglia or internal capsule, if there is much tearing up of the brain substance the blood may escape into the *lateral ventricles* and from there extend under the pia arachnoid   Hæmorrhage under the pia mater is also observed when the ruptured vessel is outside the brain substance

Naked eye Appearances —On removing the skull cap and reflecting the dura mater, a general *flattening of the convolutions* is usually observed   Sometimes the flattening is more marked on one side (the side of the hæmorrhage) than the other   In the case of hæmorrhage into the lateral ventricles, or hæmorrhage from one of the larger vessels before it enters the brain substance, or from an aneurysm of a large vessel, extravasated *blood may be seen in the subarachnoid space* sometimes extending on to the vertex, but usually more marked at the base of the brain

On section of the brain, a larger or smaller area of *cerebral substance is found torn up and the space occupied by blood clot*   In older hæmorrhages the clot becomes brownish in colour, and the surrounding tissue is stained yellow

In all cases of cerebral hæmorrhage, as already stated, careful examination should be made of the vascular system— vessels and heart—and of the kidneys   The vessels as a rule show more or less marked arterio-sclerosis, the heart shows hypertrophy of the left ventricle and in some rare cases acute endocarditis   The kidneys very constantly show more or less marked chronic interstitial nephritis, which may be of the arterio-sclerotic type

Following on a hæmorrhage there is always, if the patient survive, more or less *secondary degenerative change in the nerve tracts which have been interrupted*   Thus when the hæmorrhage occurs into one internal capsule there will be descending degeneration in the direct pyramidal tract of the

same side and in the crossed pyramidal tract of the opposite side in the spinal cord

Superficial hæmorrhage may also be caused by *laceration of the brain substance* due to injury If the patient survive some time, red or yellow softening occurs (see p 304)

Microscopically, there is little to be seen beyond the extravasation of red blood cells In older hæmorrhages there is more or less pigmentation from deposit of hæmatoidin in the parts around There tends also to be an increase of connective tissue (neuroglia and fibrous tissue) around the clot

INFLAMMATION OF THE BRAIN (ENCEPHALITIS)

In the brain substance subjacent to inflamed meninges in the neighbourhood of injuries, blood clots, areas of softening, and tumours there is always more or less marked inflammatory change *showing itself in degenerative changes in the ganglion cells and nerve processes, proliferation of neuroglia, infiltration with mononuclear cells particularly around vessels*

Types

    1 Simple encephalitis following injuries, etc (see above)

    2 Acute non suppurative encephalitis (epidemic encephalitis or encephalitis lethargica)

    3 Suppurative encephalitis (abscess)

    4 Tuberculosis

    5 Syphilis   Gumma   General paralysis

    6 Chronic encephalitis

Epidemic Encephalitis (Encephalitis Lethargica) —This disease, which appears to be a new one, was described first in Austria in 1917 by Economo It is characterised by very variable symptoms Severe cases often pass into a lethargic state from which they may recover after some weeks Ocular paralyses are common, also contraction, spasm, and tremor of muscles The sequelæ are many and very various

The causal organism is as yet unknown, but there is evidence suggesting that it is a filterable virus resembling but not identical with that of poliomyelitis

Pathological changes are limited to the brain and its membranes, and are often very inconspicuous   In the more acute cases the surface vessels show a striking distention sometimes accompanied by minute hæmorrhages   Beyond this there may be nothing visible to the unaided eye   Occasionally there are large hæmorrhages   The characteristic lesions in the brain itself are often localised in the mid brain, more especially in the following situations, nucleus of the third nerve, substantia nigra, red nucleus, but often extending upwards into the basal ganglia and downwards into the medulla   Cases which die in the acute stage of the disease show an œdema of the cerebral tissue and of the nerves arising from it, minute hæmorrhages, filling of the peri vascular lymph space with round cells, and chromatolytic changes in the cells of the nuclei of the cranial nerves   In the later stages endothelial and neuroglia proliferation occurs with subsequent shrinkage   Pigmentation also takes place following the hæmorrhages   There is little to note in the meninges beyond the congestion of vessels mentioned above, and there is no constant or characteristic alteration of the cerebro-spinal fluid

General Paralysis—This is a disease found chiefly in males between the ages of thirty and fifty   Like locomotor ataxia it is a syphilitic affection, spirochætes being demonstrable in the cerebral tissue in suitably stained preparations

If death occurs during the early stage, little more than swelling and congestion of the brain substance is found   In the later, paralytic stages there is found thickening of the membranes of the brain, sometimes also of the calvarium Pachymeningitis hæmorrhagica (see p   298) may be present

There is a reduction in the size of the brain as a whole The pia-arachnoid shows opaque areas and is very œdematous The convolutions are atrophied, and the enlarged sulci contain excess of cerebro spinal fluid which may be tinged yellow   The meninges are often adherent to the brain

substance The lateral ventricles are dilated, contain excess of fluid, and the ependyma shows minute granulations

Microscopically, the nerve cells of the cortex and other parts are shrunken and atrophied, and many of them have disappeared Their processes are wasted and interrupted There is overgrowth of neuroglia taking the place of the ganglion cells The vessels are thickened and enveloped in sheaths of mononuclear cells The cerebro spinal fluid is rich in lymphocytes and plasma cells, and gives a positive Wassermann reaction in high dilutions

Suppurative Encephalitis (Cerebral Abscess) —Two types may be distinguished (1) *Pyæmic*, (2) *Solitary*

The *pyæmic* type is usually minute, and consists of numerous abscesses scattered irregularly through the brain substance There is usually hæmorrhage around the abscesses owing to the vessels damaged by the inflammatory process giving way

The *solitary abscess* is commonly due to extension of inflammation from neighbouring parts, as a rule to *middle ear disease* (suppurative otitis media) or *suppuration in the mastoid antrum* Thus the common sites of abscess of the brain are the *temporo-sphenoidal lobe* (Fig 99) and the *cerebellum*, the two portions of the brain nearest to this suppurative focus Occasionally such abscesses are due to injuries The size of the abscess varies much It may be the size of a walnut or even a tangerine orange The wall may be formed of softened, ragged cerebral tissue, or of a layer of granulation tissue, depending upon the age of the abscess The contents consist of pus which may be white, yellow, or greenish, and is often very foul smelling The organisms found are many and various—streptococci, staphylococci, B *pyocyaneus*, etc.

There is a rare and unexplained association between solitary abscess of the brain and pulmonary diseases such as bronchiectasis and empyema.

Microscopically, the appearances are those usually seen in abscess formations—accumulations of polymorphonuclear leucocytes with necrotic debris and germs of various kinds In the brain substance around are seen hæmorrhages, infiltration of the cerebral substance with inflammatory cells of various types, particularly round the vessels, and degenerative changes in the ganglion cells and other nerve elements

Tuberculosis —*Miliary tuberculosis*, when it occurs in the brain, shows a more marked tendency to affect the meninges than the cerebral substance In tuberculous meningitis, however, there is always a tendency for the inflammatory change to pass downwards into the brain substance Occasionally one meets with *multiple caseous foci* in the brain substance, but a more common manifestation is the *solitary nodule* which is found specially in relation to the cerebellum and more commonly in children Such nodules often act like tumours, producing pressure symptoms

Syphilis, like tuberculosis, when it occurs in the brain, shows a tendency to affect the meninges and vessels In the latter case, *periarteritis* and *endarteritis* are not uncommon Occasionally, *gummata* are met with, which, like the solitary tubercle nodules, act as tumour formations Such gummata consist of a caseous centre with surrounding granulation tissue

In addition there is the diffuse form of encephalitis already discussed under general paralysis

Chronic Encephalitis —This may follow injury, softening, hæmorrhage, or the more acute types of epidemic and suppurative encephalitis It may also occur in certain forms of insanity, in Huntingdon s chorea, and in the cerebral form of disseminated sclerosis

CEREBRO SPINAL FLUID IN ENCEPHALITIS AND MENINGITIS

In the lethargic form there is no marked change, although in a few instances the mononuclear cells are increased In

general paralysis (and tabes dorsalis) in addition to the positive Wassermann there is an increase of cells and globulin   The fluid is usually clear and contains an increased amount of globulin in tuberculous meningitis   The cell count is increased, the predominant type being the mononuclear   The acute pyogenic forms of meningitis give rise to turbid cerebro spinal fluid which contains a very large number of polymorphs and a large amount of protein, chiefly globulin   The findings in case of cerebral abscess depend on the situation of the lesion   If the abscess communicates with the meninges a purulent meningitis will be set up   A deep-seated abscess may not cause any change in the fluid

TUMOURS

The brain substance is formed of (1) nerve cells and their processes, which are epiblastic in origin and practically never give rise to tumour formations, (2) neuroglia or binding connective tissue of the brain, also epiblastic in origin, which is the source of a majority of the primary growths of the brain, (3) vessels, endothelium of meninges and ordinary connective tissue, mesoblastic in origin, which may be the origin of sarcomata and angiosarcomata, (4) the ependyma lining the ventricles from which carcinomatous tumours may arise

Tumours of the brain are more common during the first four decades of life, this is due partly to the inclusion of the granulomata in the category of cerebral neoplasm, partly to the fact that gliomata tend to occur before middle life, and carcinomata even as secondary deposits are rare   Cerebral tumours are more common in the male than in the female, and they show a more pronounced relationship to trauma than is the case with neoplasms in other parts of the body

Types

A Primary Tumours
    1 Gliomata.
    2 Sarcomata, endotheliomata, angiosarcomata psammomata, etc
    3 Carcinomata.
    4 Cholesteatomata.

B Secondary Tumours.
    1 Granulomata
        (a) Tuberculous nodules.
        (b) Gummata
    2 Sarcoma
    3 Carcinomata.

C Cysts.

Primary Tumours of the Brain.—The commonest of these is the *glioma* This may occur in any part of the brain The tumour varies in size, and has a grey, pink, or white appearance, and is not well defined Sometimes it is translucent, at other times opaque Hæmorrhages frequently occur in it The tumour may be simple, but often is malignant, and is then called a *glio-sarcoma*

Microscopically, the simple type shows branching *cells* with small round nuclei and long "spider leg" processes which interlace with one another, forming a felted network between the cells In the malignant types the cells are more numerous, larger, and more irregular, and the intercellular material is correspondingly reduced in amount

Other forms of *sarcomata* found in the brain are *angiosarcomata*, characterised by marked vascularity and tendency to hæmorrhage, *endotheliomata*, with the sub variety *psammomata*, which occur mainly in connection with the meninges (see pp 366-67)

As already mentioned, primary *carcinomata* are occasionally met in the brain, arising from the ependyma of the ventricles

A curious and rare but interesting tumour is the *cholesteatoma* (Fig 101), also known as the " pearl " tumour from the mother-of pearl appearance of the surface It is a solitary tumour, well defined from the brain substance, occurring in connection with the meninges chiefly towards the middle line On section it is soft and has a white, laminated appearance On microscopic examination it shows layers of what

appear to be epithelial cells, with a small amount of subjacent connective tissue and a large amount of laminated dead epithelium   Some regard the tumour as arising from the pia mater, and therefore as being an endothelioma , others consider it to be formed of skin epithelium and therefore a teratoma

Secondary tumours are relatively common in the brain Both sarcomata and carcinomata are met with   The growths may be single and large or numerous and small   Secondary carcinomata are usually associated with scirrhous cancer of the breast

Under this heading may be included the so-called "granulomata" or nodules composed of chronic inflammatory tissue usually with caseous centres, and either tuberculous or syphilitic in origin   In no other part of the body are such nodules regarded as tumours   In the brain, however, not only because of their appearance but also on account of the effects which they produce, the term tumour may be applied to them   The tuberculous nodule occurs commonly in children, and is found most frequently in the neighbourhood of the cerebellum, usually on the surface

Cysts —These may be of the nature of dermoids or due to the presence of the cystic stage of a tapeworm, usually the tænia echinococcus   Cysts of the brain also occur following softenings or independent of such   The cerebellum is a common situation for the latter, which are probably con genital   Cystic degeneration of gliomata is not infrequent

DISEASES OF THE SPINAL CORD

CONGENITAL ABNORMALITIES

Spina Bifida —This is a congenital malformation due to incomplete closure of the coverings of the spinal cord, as a rule, in its lower part   Various degrees of the condition are met with, from one where the only superficial indication of

the presence of an abnormality is a tuft of hair over the lower lumbar region (*spina bifida occulta*) to one where skin in addition to the posterior bony wall of the spinal canal is absent The common type is one where there is incomplete closure of the bony canal posteriorly associated with a tumour in the lumbar region which may contain meninges only (*meningocele*), or nerve elements in addition to meninges (*meningo-myelocele*) Cases of spina bifida, if at all marked, do not live long   Infection occurs sooner or later through the skin and spinal meningitis results

Syringomyelia is a rare condition of the spinal cord in which there is a tumour like overgrowth of the neuroglia (*gliosis*) in or near the centre of the cord   The overgrowth is in a longitudinal direction and is found in the cervical, sometimes in the cervical and dorsal regions of the cord Usually, either throughout the affected part or in some portions of it, there is a cavity in the centre of the area of gliosis This condition of gliosis associated with cavitation is known as syringomyelia   The cavity is larger than and distinct from the central canal   The proper nerve structures of the cord are atrophied in consequence of the pressure of this mass of connective tissue   In outward appearance the cord may be unaltered or may be enlarged

Microscopically, in the affected area tissue consisting entirely of neuroglia is found.   In this tissue there is a space or cavity which may or may not be lined with epithelium.

Hydromyelia.—This is a condition corresponding to hydrocephalus, in which there is an over-distention of the central canal with fluid

INFLAMMATION OF THE MEMBRANES OF THE CORD (SPINAL MENINGITIS)

As in the case of the brain, two primary types may be distinguished   (1) pachymeningitis or inflammation of the

dura mater; (2) leptomeningitis or inflammation of the
pia arachnoid It is unnecessary to discuss the causation
and the various forms of the condition, as these have already
been considered under cerebral meningitis The two con-
ditions are commonly combined, the term cerebro-spinal
meningitis being employed Sometimes the inflammatory
change commences in the brain and spreads secondarily to
the cord; at other times the reverse is the case In addition
to spread from the brain, infection may reach the spinal
meninges from an inflammatory focus in one of the vertebræ,
from the blood or from the skin surface in cases of spina
bifida and bed sores.

INFLAMMATION OF THE CORD (MYELITIS)

Under this heading are included a number of conditions of
very various origin Myelitis may be due to the action of
irritants and organisms, or it may be due merely to pressure
or alterations of circulation The causes may be classified as
follows (1) *Extension of inflammation* from vertebræ or
meninges (2) *Organisms and toxins brought by the blood stream,*
such as the viruses of tetanus, hydrophobia, influenza, acute
poliomyelitis, etc. (3) *Pressure of dislocated vertebræ or tumour*
(4) *Circulatory disturbances*—thrombosis in sunstroke, embolism
in "Caisson" disease Probably under this heading may
also be included the cases due to "chill"

As regards the *distribution* of the change, the part involved
may be mainly the grey matter, when the name poliomyelitis
has been applied Or it may be that the white matter is
chiefly affected As a rule, both are implicated When the
whole diameter of a section of cord is affected, the term
transverse myelitis is used If the change is irregularly
scattered up and down the cord, the term disseminated is
employed.

The *morbid anatomy* of the condition varies according to

the rapidity of the change and the stage at which it is observed
In the early stages all types are characterised by a *softening
of the cord substance*   In testing for the presence of the
condition, the finger should be gently passed down the cord
and any alteration in consistence noted

On section of the cord, in addition to the softening, there
may be *increased vascularity*, which gives a pink appearance
to the grey matter more especially   Sometimes *small
hæmorrhages* are present, and occasionally the cord is so
softened that the line of demarcation between grey and white
matter is rendered indistinct

The *later stages* are accompanied by an *overgrowth of
neuroglia* replacing the degenerated nerve elements   This
may manifest itself by atrophy and contraction and by the
appearance of grey translucent areas with variable distribu
tion, a condition often characterised by the term sclerosis
Degenerative changes occur in the tracts running upwards
and downwards from the area or areas involved.

Microscopic changes —These are similar to those found in
encephalitis

   (i.) *Changes in the nerve cells* —These consist in a
disappearance of the Nissl spindles, loss of staining capacity
in the nuclei with margination and eventual extrusion

   (ii.) *Changes in the processes of the cells* —Swelling, bead
ing and fragmentation of axis cylinders and other processes
Degenerative changes in the myelin sheath associated with
setting free of fat in a demonstrable form.

   (iii.) *Changes in the neuroglia* —Swelling and proliferation
of the cells, many of which become free and act as phagocytes
taking up fat globules and appearing as large vacuolated cells
(compound granular corpuscles)   In the later stages the
proliferated glia cells settle down to form more or less extensive
areas of gliosis, replacing the nerve elements

   (iv) *Vascular changes* —Hæmorrhage or thrombosis may
be met with.   Exudation of fluid and of leucocytes occurs to
a greater or less marked extent, depending upon the acuteness
of the inflammatory change   A very constant appearance is

a filling of the lymph space which surrounds the vessels of the cord (perivascular lymph space) with cells which may be polymorphonuclear leucocytes, lymphocytes or vacuolated phagocytic cells of uncertain origin, according to the type and the acuteness of the change.

In the areas of secondary degeneration above and below the level of the lesion there is disappearance of the nerve elements —axis cylinders and myelin sheaths—and a replacement of these by an overgrowth of neuroglia.

DISEASES OF THE BRAIN AND SPINAL CORD TO WHICH SPECIAL NAMES ARE GIVEN

There is a number of diseases which affect mainly the spinal cord to which special names are given. Some of these are inflammatory in origin, due to the action of poisons upon cells and their processes, others are degenerative. No hard and fast line can be drawn between these two sets of causes, however. No system of classification is attempted, because in many cases the site of the primary change, whether in nerve cell, nerve process or nerve ending, is uncertain. Only the more important conditions are included.

Acute Poliomyelitis. — This condition was originally known as *acute anterior poliomyelitis* and, in its later stages, as *infantile paralysis.* At first thought to be circulatory in origin, due to blocking of the anterior spinal artery by embolus or thrombus, it is now regarded as organismal in nature, due to a specific virus the exact nature of which has not yet been shown. The virus passes through a porcelain filter and is infectious for monkeys. The disease may be epidemic or sporadic. It occurs mainly in young children, usually in the late summer and autumn months. It is associated with more or less marked fever, and later on with the development of paralysis in muscles.

The condition may be met by the pathologist in the

early, acute stage, or in the later stage, when there is atrophy and contracture of limbs

In the *early stage* the condition has the appearance of a myelitis affecting the whole of the substance of the cord, not merely the grey matter, although the change may be most intense in the latter   As regards distribution the change may be met with in the cervical or lumbar portions of the cord   Usually there are alterations to be found throughout the cord, sometimes also in the medulla and cerebrum   The site of the most intense change may or may not show softening   Sometimes there is a slight degree of inflammation of the meninges   On section of the cord there is usually congestion of the grey matter, and sometimes there are scattered hæmorrhages

Microscopically all the changes described in connection with myelitis may be met with   There are degenerative changes in the anterior horn cells, infiltration of the grey matter with cells partly leucocytes   more especially lymphocytes, partly multiplied neuroglia and connective tissue cells   Small hæmorrhages may be present.   Degenerative changes may also be found in the white matter, but the most obvious change is an infiltration of the perivascular lymph sheath of the vessels with cells, chiefly lymphocytes   There is usually a varying amount of inflammatory change in the meninges.

The *later stage of the disease* is connected pathologically with atrophy of the grey matter, more especially of the anterior horn, sometimes unilateral, at other times bilateral   This shrinkage is associated microscopically with a disappearance of the nerve elements and overgrowth of neuroglia   There is also present a descending degeneration in the motor tracts and nerves

Progressive Muscular Atrophy (chronic anterior poliomyelitis) —This is a condition which develops in middle life, usually in males   Overstrain, injury, exposure to severe cold and infective disease have been put down as causes   It is

characterised by a progressive atrophy of the muscles, usually beginning in hand and arm, especially the right hand

The primary pathological change is a degeneration with atrophy in the anterior horn cells of the grey matter in the lower cervical region

In the disease known as *amyotrophic lateral sclerosis*, which is believed by many to be the same condition, in addition to the degenerative change in the motor cells, there is sclerosis in the crossed pyramidal tracts

Disseminated or Insular Sclerosis—This is a disease which usually commences in early adult life   Nothing definite is known as regards its etiology, although in some cases an association with acute *infective* disease has been established   It is characterised clinically by (1) a spastic condition of the limbs associated with weakness, (2) tremors, (3) alterations of speech, (4) nystagmus

As regards the pathological anatomy, the lesions are usually found in the spinal cord, less frequently in brain, pons and medulla, and consist in scattered, grey, transparent areas of sclerosis, varying much in size and shape, and having no relation to any structures or tracts of nerves

The patches occur in grey and white matter alike and are sharply defined from the surrounding healthy tissue   As a rule, ascending and descending degenerations are absent

Microscopically, in the sclerosed areas the medullary sheath is found to have disappeared entirely, although sometimes the axis cylinder is still present   The place of the degenerated nerve elements has been taken by proliferated neuroglia. Ganglion cells persist for long in diseased patches   In the earlier stages and at the margin of older areas numerous granular cells containing fat globules are found   The vessels in relation to the patches often show alteration, such as peri and endarteritis.

Locomotor Ataxia (Tabes Dorsalis).—This disease has a very definite relationship to syphilis   It is characterised

clinically by a peculiar stamping gait, absence of knee jerks,
loss of sense of position, Argyll Robertson pupil, optic
atrophy, various paralyses, etc

The changes found in fatal cases of the disease are most
marked in the spinal cord, which shows a sclerosis of the
posterior columns To the naked eye these columns are
translucent and shrunken There is often thickening of the
membranes over the posterior portion of the cord On more
careful examination the distribution of the sclerosis is found
to vary according to the level examined In the common
variety, where the change commences in the lumbar region,
examination of the cord at that level shows degeneration
in the postero external column Sometimes, in the more
advanced cases, both postero-external and postero-internal
are sclerosed In such cases the upper dorsal and the cervical
segments show the degeneration mainly in the postero-
internal tract This is due to the fact that the sensory fibres
which run in the posterior columns do so first in the postero-
external tract and then gradually pass into the postero-
internal on their way to the ganglia in the medulla In
cases of cervical tabes, on the other hand, the change is found
in the postero external tract in the cervical region In
combined cervical and lumbar cases the whole of the posterior
columns is affected Occasionally other ascending tracts,
such as the direct cerebellar and antero lateral ascending are
implicated

Microscopically, in the sclerosed areas there is found a
disappearance more or less complete of the axis cylinders and
medullary sheaths and a replacement of these by neuroglia.

In addition, degenerative changes are found in the cells
of the spinal ganglia in some cases (see changes in nerve cells,
p 317) also in the peripheral portions of the sensory nerves

Thus there is in tabes a progressive degenerative change
in the sensory neurons of the cord, most marked in the intra
medullary fibres of the posterior sensory neuron, followed by

a proliferation of the neuroglia As regards the primary change there is great uncertainty and considerable difference of opinion Some regard it as being the sclerosis of the posterior columns, others a local meningitis implicating the posterior roots as they pass through the meninges and so cutting them off from their trophic centres Others again say that the degeneration of the cells in the posterior root ganglion is the first lesion

Hereditary Spinal Ataxia (*Friedreich's Ataxia*)—This is a disease which usually affects several members of the same family The lesion in the spinal cord is similar to that found in locomotor ataxia but in addition to the sclerosis of the posterior columns there is a similar change in the lateral parts of the cord affecting the crossed pyramidal tracts, sometimes also the direct cerebellar and antero-lateral-ascending tracts

Huntingdon's Chorea.—Huntingdon's chorea may be defined as an hereditary form of the disease bearing no relation to so-called rheumatic chorea It is often traced through several generations, and affects both sexes equally The symptoms usually begin about middle life and consist of choreic movements and ataxy with progressive mental enfeeblement

The disease is apparently a gliosis, more especially of certain portions of the central nervous system, but a general diminution in size of brain and cord is usually to be noted The parts of the brain which are specially implicated are the convolutions of the prefrontal and motor areas, the putamen and neighbouring basal ganglia

There is an increase in the cerebro-spinal fluid (external hydrocephalus) The meninges may be thickened, but this is by no means constantly found, and pachymeningitis hæmorrhagica may be present Careful examination of the grey matter of the convolutions of the prefrontal and motor areas shows a narrowing of these There is atrophy of the

grey matter of the basal ganglia, particularly of the putamen portion of the lenticular nucleus   This shrinkage leads to a dilatation of the lateral ventricles with passive increase of fluid, or internal hydrocephalus

Microscopically, the change in the motor cortex can only properly be appreciated if section stained on the one hand to show the nerve cells and their processes, on the other the neuroglia, are compared carefully with normal preparations from the same regions.   When this is done it will be found that the third layer of pyramidal cells, known as the giganto-pyramidalis, shows more or less marked diminution in its ganglionic elements.   The cells which remain show a thinning of the layer of protoplasm round the nucleus   The protoplasm stains a uniform dark colour and exhibits no finer structure at all   In other words, the Nissl bodies have lost their outline and definition and the whole cell is atrophied   The nuclei stain deeply but are ill-defined

The dentrites of the cells are shrunken and corkscrew like. Coincident with this change in the ganglion cells is an increase in the neuroglia cells   An unstained margin is visible round the nuclei of these cells, indicating a vacuolated protoplasm. This change is visible in a more or less marked degree throughout the motor cortex, but it is in the third or giganto-pyramidalis layer that the most pronounced alteration is to be observed.   The vessels of the cortex generally are thickened especially as regards the adventitia, and pigment, the result of accumulation of products of degeneration in the perivascular lymphatics, is to be seen

Similar changes, sometimes accompanied by small hæmorrhages and pigmentation, are found in the basal ganglia, notably in the putamen

Progressive Lenticular Degeneration (*Wilson's Disease*)

—This is another of those rare and interesting affections of the central nervous system which run in families   It has a curious and constant relationship to a form of common cirrhosis of the liver   It is a disease of adolescence, and the cause and nature of the condition are unknown

The change found after death in the central nervous system is a symmetrical degeneration of the lenticular nuclei with secondary degeneration in the tracts passing from them The putamen and the globus pallidus are the structures chiefly affected These may show all degrees of disintegration from a worm eaten appearance to complete cavitation, as in cerebral softening As stated, the liver shows a coarse form of common cirrhosis.

Microscopically, there are found degenerative changes in the ganglion cells, which disintegrate and disappear The remaining cells are atrophied and stain deeply The myelin sheaths of the fibres are broken up and there are numerous compound granular corpuscles filled with fat globules At the same time there is an overgrowth of neuroglia and a hyaline degeneration of the vessel walls.

Tumours

Tumours of the cord or its membranes are rare Apart from tubercle nodules and gummata, the commonest growth is the glioma, next comes the sarcoma Secondary growths, both sarcomata and carcinomata, are occasionally met with

More common are tumours in the vertebræ—sarcomata and carcinomata—pressing upon the cord and leading to myelitis

DISEASES OF THE PERIPHERAL NERVES

Neuritis, or inflammation of the nerves, may be due to (1) bacterial poisons such as in diphtheria, (2) chemical poisons such as alcohol, arsenic, lead, and gout, (3) trauma, (4) extension of inflammation from adjacent parts.

It is customary to distinguish two types (*a*) parenchymatous neuritis, in which the degenerative change in the axis cylinders and medullary sheath is the main thing, (*b*) interstitial

neuritis, in which the overgrowth of the fibrous tissue elements
of the nerve is the chief process   There is in reality no hard
and fast line between the two types   When the poison is,
as in diphtheria, rapid in its action, the degenerative change
predominates , when the poison is, like tuberculosis or leprosy,
slow in its effect, the interstitial process is in the ascendant.

In the more acute cases, beyond some swelling and
increased vascularity of the nerve, there is little to be seen
with the naked eye   In the more chronic types, nodules of
granulation tissue and fibrous thickening are met with.

Microscopically, specimens treated with osmic acid will
show black colouration of the myelin sheath   There is
infiltration of the connective tissue with inflammatory cells,
more marked in the chronic cases

Tumours —The commonest growth is the fibroma (so called
neuro-fibroma)   Such tumours are often multiple. They occur
along the distribution of certain nerves, usually under the
skin, but sometimes in the internal organs such as heart,
stomach, and intestines. This diffuse form of neuro-fibroma
tosis is often known as Recklinghausen s disease or fibroma
molluscum   Occasionally the nodules undergo a sarcomatous
change.

CHAPTER XII

DISEASES OF BONES AND JOINTS

DISEASES OF BONES

RICKETS

THIS is essentially a disease of infancy, although the results of it tend to persist throughout life   The underlying factor in its production is a deficiency of calcareous material in the newly formed bone

The causation of the disease is still obscure, but deficient amount of lime salts in the food or failure to make use of the lime salts already present is, in all probability, the explanation of the relative absence of these salts in the bones   Some ascribe the condition to defective action of ductless glands, which produce an internal secretion, such as the pituitary and suprarenal

The changes found in the body in cases of rickets are as follows —

1 *Enlargement of the head* with prominence of the pro-tuberances of the skull and thinning of the remainder of the bony walls (craniotabes)   The fontanelles remain open for an unusually long period

2 *Enlargement of the epiphyses of the long bones and of the costo chondral junctions*   The latter condition results in the formation of a double row of nodules, the so-called

"rickety rosary" (Fig 105) On section of one of these nodules the line of junction between bone and cartilage, which should be more or less straight, is very irregular and vascular

3 *Deformation of the bony skeleton* as a result of the softening associated with the absence of lime salts

(*a*) Prominence of the sternum

(*b*) Curvature of the spine (kyphosis and scoliosis)

(*c*) Curvature (occasionally fracture) of the long bones such as the femur Sometimes consequent on the bending, a new formation of bone takes place along the concavity of the tibia or femur (buttressing)

(*d*) Narrowing of the pelvis antero posteriorly, resulting in difficulty during parturition Also throwing out of the iliac bones

In addition, there is often abnormal prominence of the abdomen, and dentition is usually delayed

Microscopically there is found at the epiphyses of the bones and at the costo-chondral junctions (*a*) a broadening of the zone where the cartilage cells are undergoing multiplication, at the same time there is irregularity in the arrangement of the cartilage cells

(*b*) Irregular calcification of the cartilage

(*c*) Penetration of blood vessels into the cartilage

(*d*) Formation of a spongy osteoid tissue with deposition of lime salts which can be demonstrated as granular material, rather than a combination of the lime salts with connective tissue to form true bone.

At the same time there is a laying down of a layer of vascular tissue under the periosteum which later undergoes ossification.

OSTEOMALACIA

This is a rare disease, found especially in certain localities, e g the Rhine Valley and Flanders It is more frequent in females and has a definite relationship to pregnancy

It is stated to have been cured by the removal of the ovaries

The condition is essentially a decalcification of the bony trabeculæ, beginning at the surface of the bones, with, at the same time, a tendency to the formation of new bone which remains imperfectly calcified As the result of the process of softening and under the influence of pressure, the bones become deformed and sometimes fractured

The pelvic bones, owing to the great pressure to which they are subjected, are usually the most deformed, with the result that there is a crumpling of the bony wall of the pelvis, so that the cavity is greatly narrowed Other bones, such as the vertebræ, clavicles, and femur, undergo a similar process of bending

INFLAMMATION OF BONE

The inflammatory process as it occurs in relation to bone shows certain peculiarities due in great measure to the physical characters of the tissue and to the anatomical arrangement of its constituents

From the point of view of inflammation, three different parts of a bone may be distinguished—(1) the *periosteum*, a vascular connective tissue structure which covers the exterior of the bone and from which the nourishing vessels enter the bone When the periosteum is stripped from the underlying bone, as it may be artificially or by the accumulation of exudate, the more superficial parts of that bone tend to undergo necrosis Further, the periosteum has the capacity of forming new bone, and under the influence of chronically acting poisons this function is stimulated (2) *The bone itself is a rigid non-expansible tissue, dependent for its nourishment upon the vessels which pass into it from periosteum and medulla.* When it is the seat of the more acute types of inflammation, the exudate from the vessels, unable to infiltrate the rigid tissue around, accumulates and presses upon the vessels, thus leading to necrosis of the bone In the less acute types of inflammation, probably in order that there

may be space for the inflammatory reaction, the hard re
sisting bone is excavated by means of large cells (osteo-
clasts)   This rarefaction of the bone is known variously as
osteo-porosis or caries   (3) *The medulla or bone marrow*, also
a vascular tissue, having as its function the nourishment of
the bone and also the formation and destruction of blood

When inflammation attacks bones the process usually
commences in one or other of the vascular structures—
periosteum or medulla, by far most commonly in the latter
As the process extends, it tends to involve the other structures,
so that periostitis usually accompanies osteomyelitis and
vice versa

As the inflammatory conditions of bone are more common
in childhood, the relationship of the primary focus to the
epiphysis is important   The infection takes place usually in
that portion of the diaphysis which abuts upon the epiphyseal
cartilage   This is the point where the growth of bone is
most active and where blood vessels are most numerous

The causation of the inflammatory process may be (1)
injury, (2) organisms such as the pyogenic cocci, *B typhosus*,
B tuberculosis, the organism of syphilis, etc.

Three processes are found going on, often side by side, in
inflammation of bone   (1) *Necrosis or death of bone*, (2)
New formation of bone which is often hard (sclerosis) but may
be porous, (3) *Rarefaction* of the pre-existing or newly formed
bone (osteo porosis or caries)   In the case of the *more acutely
acting irritants* the necrotic process tends to predominate,
owing to the tendency for exudate to accumulate and to
obliterate vessels and separate periosteum   In the case of the
more chronically acting poisons—prolonged coccal infection,
tuberculosis and syphilis—the rarefying process is met with
along with new formation of bone   This laying down of new
bone is merely a modification of fibrosis or interstitial inflam
mation due to the fact that the new connective tissue contains
bone forming elements.

Acute Osteomyelitis.—This condition sometimes occurs during the course of specific fevers, but often occurs spontaneously Young children are particularly susceptible Sometimes there is a history of an injury to the bone, at other times the disease arises without any such predisposing cause The condition is an organismal one, *staphylococcus pyogenes aureus* being very commonly present, but other *staphylococci*, *streptococci*, and *B typhosus* are occasionally found The organisms reach the bone marrow by way of the blood stream, having been absorbed from the throat or intestinal tract or other focus of infection They deposit themselves in the vascular, growing area of the diaphysis which is in immediate contact with the epiphysial cartilage The area of marrow involved shows congestion of its vessels, purulent infiltration, and hæmorrhages Sometimes localised areas of suppuration (abscesses) develop in the bone From the medulla the inflammatory process passes by way of the Haversian canals to the periosteum, where pus accumulates, raising the membrane from the underlying bone In this way *necrosis*, more or less extensive, may occur in the shaft of the bone with formation of *sequestra* Sometimes the epiphyses and joints are involved Reaction of the bone-forming tissue begins after the acute stage is over and the pus has been evacuated or has found its way to the surface An involucrum or envelope of new bone forms around the original shaft, and if the infection persist the chronic stage of the process ensues

Owing to the occurrence of thrombosis in the veins in the neighbourhood and subsequent infective softening of the thrombi, *metastatic abscesses* and *septic infarcts* may form in other parts and organs, especially in the lungs. *Pericarditis* is not an uncommon accompaniment of acute osteomyelitis, the infection being carried by the blood

The bones most frequently affected are the femur, tibia, and humerus, the order of frequency, according to Fraser,

being as follows upper end of tibia, lower end of femur,
lower end of tibia, upper end of humerus   Other bones may
be the seat of the change by extension of inflammation from
neighbouring parts, *e g* the bones of the skull or finger in
cases of septic wounds   Rarely the vertebræ may be affected

Chronic Osteomyelitis —Healing of the inflamed focus
may occur spontaneously, or, as is most usually the case, the
diseased area may be removed by the surgeon, and healing
result   At other times the inflammatory change persists
Organisms remain in portions of dead bone (sequestra), and
the irritation is kept up   From such foci a purulent dis
charge is constantly flowing, which finds its way to the surface
by openings in the bone (cloacæ) and sinuses in the soft
parts   At the same time the periosteum, kept in a constant
state of proliferation, forms new bone which may enclose the
sequestra or dead areas, forming what is called a "new case"
This new bone usually has a spongy character but may be
dense (Fig 106)

Waxy disease is not infrequently found in relation to
chronic suppurative conditions of bone

Tuberculosis of Bone —Tuberculous disease of bones is
met with more especially in young children, *i e* in growing
bones, although the results of such disease are often seen in
the adult. A large percentage of cases are due to infection
with the bovine type of the tubercle bacillus   The organism
may reach the bone by the blood stream or by the lymphatics.
In the latter instance the primary focus is usually the synovial
membrane of a neighbouring joint The bones most frequently
involved are the vertebræ (Fig 107), femora, the tarsal and
carpal bones, and the ribs

The condition may begin in the interior of the bone,
usually in the cancellous tissue at the ends (in the case of the
long bones) or, much less frequently, in the periosteum
It appears first as a grey translucent area surrounded by a

vascular zone   This area spreads, gradually absorbing the
bone, and so producing rarefaction or caries.   At the same
time, owing to the irritation of the focus new bone may be
laid down in the neighbourhood, particularly under the
periosteum   In rapidly progressive cases, largely owing to
obliterative changes in the vessels but also due to the action
of the tubercle poison   necrosis of larger or smaller areas of
bone occurs   with formation of sequestra.

The change may spread to the surrounding parts and a
tuberculous (so-called 'cold') abscess develop in the tissues.
This is particularly the case in tuberculosis of the vertebræ,
retropharyngeal abscess occurring in connection with cervical
disease, psoas abscess in relation to lumbar disease (Fig 107)
Sometimes the focus infects the spinal cord, setting up a
meningitis.

Deformity of bone frequently follows tuberculous disease
This is more especially seen in tuberculosis of the spine.

Syphilis of Bone —Bone may be the seat of disease both
in congenital and acquired syphilis

In congenital syphilis the disease shows itself chiefly at the
ends of the long bones in the part where ossification is taking
place (syphilitic epiphysitis)   The line of calcification is
broader and more irregular than normal   The result of this
is an interference with growth leading to a form of dwarfing

In the acquired form of the disease the lesion is essentially
gummatous   Such gummata may occur in the periosteum
or in the medulla of the bone.   The process may be found in
any part of the skeleton, but it is commonest in the tibia,
ulna, sternum and calvarium   Underneath the gumma there
is erosion of the bone which has, in the case of the calvarium,
a characteristic circular appearance (corona veneris)

Sometimes thickenings occur in the bones (long and flat)
leading to the formation of raised areas (syphilitic nodes)
The newly formed bone is in these cases very dense

Osteitis Deformans (Paget's disease of bone) —This is a rare disease of advanced life

There is a general thickening of such bones as the tibiæ clavicles, skull, and vertebræ The bones are at the same time spongy and relatively light, although the medullary cavity is narrowed from the formation of new bone Owing to the softness of the bones deformity occurs, particularly in bones, such as the lower extremities, spine and clavicles, which are subjected to pressure

Acromegaly, a condition caused by disease of the pituitary gland, is associated with an enlargement of certain bones, *e g* the lower jaw, bones of the face, hands and feet   The enlargement is due to a laying down of new bone as well as to a thickening of the periosteum

Tumours of Bone — Of simple tumours, *osteomata, chondromata,* and *fibromata* are met with

Of malignant growths, sarcomata of various kinds occur primarily — *osteo-sarcomata* (Fig 108), *chondro-sarcomata, myeloid sarcomata* (Fig 109), and *myelomata*

Secondary deposits of carcinoma are occasionally met, particularly in carcinoma of the breast and prostate

DISEASES OF JOINTS

INFLAMMATION (ARTHRITIS)

Acute Arthritis

1 *Non suppurative* —This is found following injury and in connection with acute rheumatism   The joints most frequently affected are the knee, shoulder, and ankle   Several joints are usually attacked at one time   The inflammation is in the tissues around as well as in the joints themselves The latter show swelling of the synovial membrane and the presence of a thin yellowish fluid which contains usually

relatively few leucocytes although pus occasionally forms
From the inflamed synovial membrane (not from the flu d as a
rule) *micrococcus rheumaticus* can in some cases be cultivated

2 **Suppurative Arthritis** —This may occur in the course
of a pyæmia the organisms being conveyed by the blood,
or infection may take place directly, due to a penetrating
wound or inflammation in bone or neighbouring tissues
The germs found are the pyogenic cocci, more especially
streptococci and *gonococci*

The synovial membrane is swollen and its vessels injected
The joint contains more or less purulent fluid, often mixed
with blood. In the more severe forms, particularly the
gonococcal, there is destruction of the cartilages of the bones.

Tuberculous Disease —Tuberculosis may commence in
the synovial membrane of the joint or it may spread from the
adjacent bone

In a well marked case of joint disease there is a general
pallor of the tissues in the neighbourhood There is some
increase of synovial fluid which is serofibrinous and occas on
ally purulent The synovial membrane is thickened, some-
times with the formation of fringes The cartilage is eroded
through the invasion of granulation tissue *from the margins
of the bones*. There may be caries or sequestrum formation
in the exposed bone In advanced cases the tendons and
ligaments in connection with the joint are infiltrated with
tubercle The joints most commonly affected are hip, knee,
elbow and ankle The condition may heal, with the result
that ankylosis frequently occurs.

Rheumatoid Arthritis. —This is a disease which is
found most frequently in females The small joints of the
hands and feet are usually first affected Later on those of
the elbow and knee are involved The joints show a fusiform
swelling and contain excess of clear synovial fluid The
synovial membrane is swollen and congested, and even in
the early stage, there may be some fibrillation and destruc-

tion of cartilage   The condition is not often found in the
post mortem room in the early stage

In the later stages of the disease, erosion of cartilage with
eburnation or polishing of the bone laid bare, also new forma
tion of bone at the margins of the joint (lipping), are character
istically present.   At the same time there is marked deformity
as well as restriction of movement, due both to the lipping
of the bones and to the formation of fibrous tissue between
them

Gout —This condition should be looked for specially in the
metatarsophalangeal joint of the great toe   It shows itself
by deposits of opaque white material (salts of uric acid)
in the cartilage and in advanced cases in ligaments and
soft tissues   There is chronic inflammation in the tissues
around

Charcot s Disease of Joints —This is a rare condition,
found sometimes in individuals suffering from locomotor
ataxia and syringomyelia   There is a great enlargement of
the joint due to the accumulation of fluid in it, also increased
mobility   There is later destruction of the cartilage, bones
and ligaments, the condition being, however, painless   The
synovial membrane is thickened, and may show villous
outgrowths.

DISEASES OF THE OVARIES

THE appearances of the ovary in menstruating women should
be carefully differentiated from those seen in disease.

The organ is swollen and vascular, and hæmorrhagic areas
occur in it. Occasionally severe hæmorrhage may occur
into the peritoneal cavity. Similarly *corpora lutea*, with their
yellow colour and characteristic wavy outline, should be
distinguished from tumours.

In acute inflammations of the peritoneum the ovaries and
tubes participate in the inflammatory condition and often
show marked vascularity. This should not be mistaken for
evidence of primary inflammation in these organs. In old age
the organs undergo atrophy. The capsule becomes thickened
and shrivelled.

Tumours.—The ovary is one of the organs in which
tumours are exceedingly common. As a rule such tumours
are cystic.

Single cysts occasionally occur from dilatation of a Graafian
follicle. Solitary cysts also develop sometimes from the
parovarium.

Compound Cystic Adenoma.—This is a common tumour
which may attain an enormous size. It consists of a number

of rounded or irregularly shaped spaces enclosing a translucent or transparent gelatinous or semi-solid material containing various mucinous constituents   Not infrequently small papillomatous ingrowths are found within the cysts which divide and subdivide   When such are present the term *papilliferous cystadenoma* is applied   Such a tumour, like the similar one found in the breast may undergo a malignant transformation   When these cystic tumours of the ovary rupture they sometimes give rise to the formation of immense numbers of secondary growths scattered through the peritoneum

For microscopic appearances see pp 359, 360

Dermoid Cysts (Teratomata) —The ovary is the commonest site for this type of tumour   They vary much in size   They are recognised by the soapy looking contents mixed with hair and containing often teeth, cartilage, bone, etc (Fig 102)

Fibromata occasionally occur in the ovary, also *fibrosarcomata* which may attain a large size

DISEASES OF THE FALLOPIAN TUBES

Salpingitis —Two types of this condition are met with, viz *gonococcal* and *tuberculous*   In the former the tubes are thickened and dilated, and contain creamy or cheesy-looking pus, which in many cases is found to be sterile

In the *tuberculous* type there is a similar dilatation, thickening and tortuosity   Minute grey tubercles may be visible in the walls, the contents are often caseous   These two conditions are sometimes to be differentiated only on microscopic examination

Both give rise to localised peritonitis with adhesions, and both may be the starting point of a generalised inflammation of the peritoneum

The Fallopian tube is the commonest site for the occur

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tence of ectopic gestation. Death occurs from rupture and
hæmorrhage into the peritoneal cavity

DISEASES OF THE UTERUS

The *size of the uterus* should in all cases be measured and
its cavity investigated for developing ovum or fœtus

Thrombosis in the uterine veins is a constant occurrence
after parturition   Occasionally portions of such thrombi are
carried away, and produce fatal pulmonary embolism

Sometimes, after operations on the uterus or ovaries, a
similar accident may occur   In such cases the emboli may
originate from vessels in the neighbourhood of the removed
growth or organ or from the abdominal wound

Acute Endometritis.—This condition is a not uncommon
cause of death in puerperal cases   The disease is an infective
one, due as a rule to a *streptococcus*   A gram negative coccus
not unlike the gonococcus has been recently described as
occurring in the uterus in such cases

The organ is of course enlarged   The interior has a grey
appearance, owing to the presence of septic sloughs in the wall
There is usually a foul odour   Films from the soft necrotic
interior show immense numbers of organisms, among them
streptococci   The uterine veins are filled with thrombi, which
may be undergoing septic softening   Septic infarcts are not
uncommonly present in the lungs

Organs such as liver, kidneys and heart show extreme
cloudy swelling   Acute peritonitis localised to the neighbour
hood of the uterus or generalised throughout the peritoneum
may be present

Microscopically, the innermost portion of the uterine wall
shows necrosis. Numerous germs of various kinds are present.
Further from the lumen the uterine muscle is infiltrated with
inflammatory cells, and thrombi are found in the vessels, in

this position in suitably stained specimens *streptococci* are usually the only organisms seen

Chronic Endometritis — Two types of this condition are commonly distinguished: (1) glandular endometritis, (2) interstitial endometritis

1. *Glandular endometritis* is also called glandular hyperplasia. It is questionable whether this condition is in reality an inflammatory one   There is little or no evidence of inflammation from the microscopic point of view   The main change is a hyperplasia of the gland elements of the endometrium   It probably represents the persistence of a stage in the menstrual cycle

The uterus is enlarged and its mucous membrane thick ened, vascular and spongy   Polypoid outgrowths may be associated

Microscopic Appearances — Sections of the uterine wall show gland acini more or less regularly arranged, but often tortuous and sometimes dilated, between which is a delicate stroma of connective tissue   The gland acini may often be seen pene trating the muscular wall for some distance, so that the con dition may be confused with an adeno carcinoma of the uterine wall.   The gland cells are, however, only a single layer in thickness, and are arranged regularly upon a basement mem brane, although there is sometimes shedding of the cells

Sections of curettings from a case of this kind present a similar appearance

2. *Interstitial endometritis* is often combined with chronic metritis   It has been called fibrosis uteri   The uterus is larger, firmer, and heavier than normal

Microscopically, curettings show a dense fibrous stroma, in which the vessels are thickened   The gland acini are usually few in number and widely separated from one another

Tuberculosis of the uterus is a rare condition   It may occur as an endometritis with the development of ragged

caseous walls, or fibro-caseous nodules may occur in the wall of the uterus which is usually considerably thickened

Tumours — Of simple growths the *fibro-myoma* (leio-myoma), or tumour composed of non striped muscle and fibrous tissue, is the commonest (Fig 104) A full description is found under Tumours, p 354

Of malignant growths the carcinoma is very common. Two main types are found —

1 Squamous epithelioma occurring in the cervix

2. Columnar cell carcinoma occurring in the body or cervix.

DISEASES OF THE PLACENTA

Infarcts, i.e. areas of necrosis in the placenta, are not uncommon They are best developed in cases of eclampsia. They appear as opaque white or pale yellow areas, more or less wedge shaped, and towards the maternal surface They are caused by thrombosis in the intervillous blood spaces

Fibrosis.—Under the influence of the syphilitic virus the placenta becomes larger, firmer, and paler, and may present a dull, greasy appearance (see p. 385).

Microscopically, the chorionic villi are found to be thicker and show a marked decrease in the number of vessels. In the thickened stroma are numerous round and spindle shaped cells.

Tumours.—*Hydatidiform or vesicular mole or myxoma of the chorion* is a condition in which chorionic villi become greatly enlarged and œdematous The tumour shows immense numbers of translucent globular masses like white currants, varying much in size, *strung upon thin filaments* It may become malignant, passing into the condition known as chorion-epithelioma (p 379)

Microscopically, the globular masses show the structure of myxomatous tissue, hence the term *myxoma* of the chorion.

There is at the same time proliferation of the covering epithelial layers—syncytium and Langhans' layer.

Chorion-epithelioma is a tumour formation which, like the preceding, has a distinct relationship to pregnancy and abortion. Its appearance and nature are discussed under Tumours (p. 379). It is associated with the development of secondary growths, particularly in the lung.

DISEASES OF PREGNANCY AND THE PUERPERIUM WHICH MAY BE FATAL

It is convenient to discuss here some of the diseases of pregnancy and the puerperium which may be seen in the *post-mortem* room. Pregnant and puerperal women may, of course, die of intercurrent diseases of various kinds. Thus, heart disease and kidney disease are not uncommonly a cause of death under such circumstances. There are, however, certain conditions more directly associated with the pregnant state which may prove fatal.

In the first place there is ectopic gestation. When an ovum develops in a situation other than the uterus, such as the Fallopian tubes or ovary, death not infrequently occurs from hæmorrhage into the peritoneal cavity.

Rupture of the uterus may occur during pregnancy or during labour, with resulting fatal hæmorrhage.

Pulmonary embolism has already been alluded to as a cause of sudden death after labour.

Chorea gravidarum may prove fatal. In a case which came under the author's notice recently there was present—what is usually found in any fatal case of chorea—acute simple endocarditis of the mitral valve.

Puerperal fever, one of the commonest causes of death after labour, has already been dealt with under Diseases of the Uterus (acute endometritis) (p. 338).

Hyperemesis Gravidarum or Pernicious Vomiting of Pregnancy —This condition of severe and sometimes fatal vomiting developing during pregnancy is believed by authorities to be toxæmic in origin, and probably allied to such diseases as eclampsia and acute liver atrophy In many cases lesions of the liver, similar to those occurring in the latter disease, are found In some cases the liver shows a fatty degeneration of an extreme degree, in others there are areas of necrosis similar to those found in eclampsia, but instead of being situated at the periphery of the lobule, as in that disease, they occur in the centre Degenerative changes of a type similar to those in eclampsia are found in the kidney The condition is associated with a high ammonia co-efficient in the urine, and there is a corresponding marked reduction in the output of urea

Acute Liver Atrophy — As already stated, there is a distinct relationship between this condition and the pregnant state For a description of the lesions found in the liver see p 232

Eclampsia. —This is perhaps the commonest cause of death in such cases The disease may prove fatal either during pregnancy or *after the birth of the child* It is associated clinically with more or less marked albuminuria (sometimes also blood and casts) and with the occurrence of fits

The *cause* of the condition is at present uncertain

As regards the *post mortem findings* in fatal cases of the disease, these vary considerably in different cases There are, however, certain appearances found with considerable constancy. *Post mortem changes* are often specially well marked There is often a general *icteric tint* of the skin Œdema of the subcutaneous tissues may be present Excess of fluid in the peritoneal, pleural, and pericardial sacs is also a fairly constant finding The heart muscle is pale

and soft The organs which show the most constant changes are the liver and kidneys

The *appearances in the liver* when well marked are exceedingly characteristic The organ is usually somewhat enlarged The surface has a dark red appearance, either in whole or in part from the occurrence of more or less extensive subcapsular hæmorrhage In consistence it is usually soft The cut surface shows a yellow appearance, with hæmorrhages scattered through the substance, chiefly in the portal spaces The necrotic areas, so characteristically present when sections are examined under the microscope, are, as a rule, too small to be seen by the naked eye Occasionally the liver may show the appearances of cloudy swelling and early fatty change without the occurrence of hæmorrhages

Microscopically, there are found (1) changes in the liver cells characteristic of cloudy swelling , (2) *more or less marked* fatty change intensified round the necrotic foci , (3) areas of focal necrosis somewhat similar to those found in typhoid fever in which the liver cells have undergone extreme degenerative changes They are swollen and vacuolated, or have broken down and disappeared Fatty change is not as a rule present in the cells within such foci Endothelial cells and leucocytes *are present along with red blood corpuscles These necrotic* foci are found chiefly in the region of the lobules , (4) areas of hæmorrhage in which the tissue is infiltrated with red blood corpuscles

Changes in the Kidney —As prev ously stated, there is in the urine distinct evidence that the kidney is damaged, that, in other words, a degree of acute nephritis is present. But even in cases where the urine shows most indications of disease comparatively little change may be found in the kidney itself, more especially microscopically The organ is somewhat enlarged and pale On section, the cortex is swollen and tends to stand up above the level of the medulla (Fig 83), The colour of the cortex is a pale yellow,

occasionally with hæmorrhages scattered through it. In consistence the organ is softer than usual. Unless the case is complicated with chronic renal disease, the capsule strips perfectly, leaving a smooth, pale surface.

Microscopically, as already indicated, the changes are less marked than one would have expected from the examination of the urine. There is (1) always more or less evidence of cloudy swelling of the renal epithelial cells, especially of the cells lining the convoluted tubules. (2) There is more or less fatty change in these cells, but this is never very marked (3) There is a certain amount of shedding (catarrh) of these cells with a massing of the shed cells in the collecting tubules. (4) There may be escape of red cells into the tubules.

The appearances are, in short, those of marked cloudy swelling or of an acute catarrhal nephritis, and, as already stated, between these two conditions there is no very hard and fast line.

It should be remembered in connection with the microscopic appearances of the kidneys that a degree of cloudy swelling (toxic change) is practically constantly found in pregnancy.

As already mentioned, infarcts in the placenta are specially frequent in cases of eclampsia.

DISEASES OF THE MAMMARY GLAND

Little need be said in such a treatise about diseases of the mammary gland. Owing to their being readily removable, growths of the gland are seldom seen post mortem.

Acute inflammatory conditions (*acute mastitis*) with abscess formation are not uncommon.

Chronic inflammation (*chronic interstitial mastitis*) is difficult to distinguish clinically and by the naked eye from carcinoma. It occurs as a hard mass, ill defined, in the substance of the gland. On section it appears as white-looking tissue radiating through the fatty tissue of the breast

Microscopically, the condition is characterised by the develop ment of a large amount of well formed fibrous tissue with isolated islands of gland tissue scattered through it   Cysts formed by dilated gland acini are often present

Tuberculosis is occasionally met with in the form of multiple caseous foci surrounded with fibrous tissue scattered through the gland substance

Tumours —The mammary gland is one of the organs in which tumour formation is most common   No doubt this is due to the fact that the breast is periodically undergoing hypertrophy and involution and also to the irritation to which it is subjected from trauma and acute inflammatory processes

Simple tumours, such as adenoma and cystic adenoma, are dealt with among tumours under these headings (p 359)

Carcinomata are dealt with under adeno-carcinomata

Although primary carcinomata of the breast are seldom met with in the post mortem room, the secondary deposits are frequently seen   They may occur in the lungs (Fig 55), or disseminated through the body, often showing a marked preference for bone

DISEASES OF THE TESTICLE

Such diseases do not often come under the notice of the pathologist in the post mortem room.

Tuberculosis of the testicle is not infrequently associated with generalised tubercle and with tubercle of the genito-urinary tract   The condition tends to develop first in the epididymis and may remain localised there

Syphilis —Two chief types of syphilis are found in the testicle

  1 *Gummata* —These are firm white or yellow caseous looking masses which have to be distinguished from sarcomata

  2 *Interstitial Inflammation or Fibrosis* —A slight degree

of this is not uncommonly met with even in cases which show few other manifestations of the disease   Bands of white fibrous tissue are seen running through the characteristic slightly brownish tinged soft testicular substance

Tumours—*Sarcoma* is the commonest tumour of the testicle   It is often of the large round cell type, and in appearance (owing to accompanying necrosis) sometimes resembles a gumma   Such tumours are rarely seen in the post mortem room, but the recurrences in the retroperitoneal glands may be met   Such recurrent sarcomata may attain a large size

DISEASES OF THE PROSTATE

The prostate is one of the most important glands in the body from the pathological point of view, and this for two reasons   First because it so commonly undergoes enlargement in later life, and secondly because any increase in size obstructs the urethral channel and leads to accumulation of urine in the bladder, and to various sequelæ involving both bladder and kidneys

Normally the prostate measures 36 by 30 by 18 mm , and weighs about 20 grammes   It is usually stated to consist of three lobes, two lateral and one median lobe   It is enlargement of the middle lobe which leads to the most serious results

Hypertrophy—To what extent the simple enlargement which the gland so constantly undergoes *in old age is to be regarded as a hypertrophy and to what extent it is a neoplasm is doubtful*   In many cases the enlargement being more or less uniform, it is probably merely hypertrophy   In other instances there is a localised projection of one or other part, usually the middle lobe, when the appearances are much more in keeping with those of a tumour formation   From the microscopic point of view there is no pronounced difference between the normal gland and the enlarged one   There is hyperplasia of all the gland elements, both epithelial and

interstitial, the interglandular tissue consisting of fibrous strands intermixed with non-striped muscle and often showing areas of round cell infiltration   The gland acini are frequently dilated and cystic, and show the formation of intra-acinous projections   The lining epithelium is cubical or columnar   The concretions known as corpora amylacea are very constantly present, although they probably do not occur in such large numbers as in the normal gland   They appear as round or oval bodies with concentric lamination not unlike starch grains

As soon as the enlargement obstructs the urethral canal thickening of the bladder wall takes place, and usually also dilatation   With further increase in size of the prostate the bladder fails to empty itself completely at each urination, and the passage of instruments may be necessary in order to secure relief   This " catheter life " exposes the patient to the risk of infection with germs, and this sooner or later occurs Thus cystitis is superadded with the risk of an ascending infection involving the pelvis of the kidneys and the kidneys themselves (suppurative pyelonephritis)   Sometimes a bi-lateral distention of the ureters and double hydronephrosis follows upon the dilatation of the bladder

Acute Prostatitis may occur in association with gonorrhœa or as a result of the formation of a false passage in catheterisa tion of the urinary bladder   It may also be due to blood infection, or may be the result of spread of inflammation from rectum or bladder   Abscess formation may result, and owing to thrombosis and septic softening of thrombi in the veins pyæmia often supervenes

Tumours of the prostate are very common if one includes all the localised enlargements already mentioned under hypertrophy, classifying them as adenomata or cystic adeno-mata   True tumours also occur   Carcinomata are common either in the form of scirrhous or encephaloid cancers   They form a frequent complication of the simple enlargement, and they show a special tendency to form metastases in bones

CHAPTER XIV

TUMOURS

TUMOURS may be primarily divided into (1) Simple and (2) Malignant. There is actually no very hard and fast line between the two varieties, certain tumours being less malignant than others. Moreover, a simple tumour may become malignant. On the whole, however, the distinction is sufficiently well marked to serve as a basis for classification.

The main morphological difference between the two types is that the simple tumour is *encapsuled*, i e is more or less sharply defined from the tissues in its immediate neighbourhood, while the malignant tumour *infiltrates* surrounding tissues and erodes structures such as blood vessels. The tendency to recur when removed, and to produce *metastases* or secondary growths, both characters belonging to malignant tumours, are explained by this character of infiltration.

In deciding in a given instance whether a tumour is simple or malignant, certain points should be attended to

1 *Position*—Tumours of the intestine are usually malignant, while in the case of the uterus the commonest tumour is the simple myoma

2 *Size*—On the whole a large tumour is more likely to be malignant than a small one, although there are notable exceptions to this

3 *Ulceration*—An ulcerating tumour is much more likely to be malignant than simple

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4 *Necrosis* —Necrotic changes are more frequently met with in malignant growths, owing to their tendency to over-grow their blood supply and from other causes

5 *Hæmorrhage* is much more frequently met with around and in malignant growths, owing to their capacity to erode blood vessels, and owing to the fact that their own blood vessels are thin walled and badly supported

6 *Infiltration* of the surrounding parts, as already indicated, is characteristic of malignant growths, while the simple tumour is, as a rule, well defined

7 *Occurrence of Metastases* — If such are present the tumour is malignant It should be borne in mind, however, that simple tumours, such as the myoma of the uterus, may be multiple

Microscopic points of distinction between the two groups are as follows

1 *Resemblance to Homologous Normal Tissue* —This is much more characteristic of simple growths Malignant growths deviate more or less markedly from the normal tissues which they represent They tend to resemble more closely the embryonic equivalent of the tissue

2 *Character of Cells* —The cells of malignant growths tend to be larger and to vary in size and shape Their nuclei also are larger and often multiple Mitotic figures are frequently numerous in malignant growths and may show aberrant types, such as multipolar division

3 *Infiltration* of surrounding tissues is again a microscopic character of malignant growths, while simple tumours are encapsuled Associated with this character is the tendency to erode blood vessels and other normal structures

4 *Inflammatory changes in the tissues around* are found in connection with malignant growths, while simple tumours excite little reaction

5 *Necrosis* is again more characteristic of the malignant type than of the simple

6 Hæmorrhage more or less extensive is characteristic of malignant growths and is due as a rule to escape of red blood cells from thin walled imperfectly developed blood vessels, but may also be due to erosion of vessels by cancer cells

7 Relation of Epithelial Cells to Stroma —In glandular tumours of the simple type a basement membrane is usually present   In malignant growths this is absent

In the following description of the common tumour formations no elaborate system of classification is adopted Any such system of classification must of necessity be tentative, pending the discovery of the cause of tumour growth Further, exceptions to rules are so frequently met with in relation to neoplasms that the most elaborate system breaks down at many points unless each tumour be placed in a category by itself

In addition to the pathological names in common use for tumours there are some terms employed more particularly by clinicians, which require definition

Polypus or *polyp* is a term applied to any mass growing from a mucous surface and attached to it by a narrow stalk Such polypi are to be found in the nose, rectum, bladder, and uterus   They vary much in structure, some, *e g* the nasal polypus, consists merely of œdematous mucous membrane, others are papillomata, myomata, or adenomata

Nævus is a name given to two types of growth which occur on the skin   the angioma and the pigmented mole   The term is derived from a Latin word meaning *birth mark* Hence its application to two different conditions

Mole is used for a form of birth mark found on the skin which is deeply pigmented with melanin and sometimes covered with hairs   It is also employed in the term hydatid form mole to characterise a degenerative or neoplastic condition of the chorionic villi which sometimes occurs in pregnancy

A. SIMPLE TUMOURS

Tumours composed of Fibrous Tissue

Fibroma —This is a tumour composed of connective-tissue cells and fibres   Two types, *soft* and *hard*, are distinguished, according as the cells or the fibres pre dominate

Sites —They may arise anywhere where there is con nective tissue,—cutis, fascia, periosteum, dura mater, sub-mucous tissue, pharynx, and nose (polypi)   They are also common as minute growths in the medulla of the kidney   Sometimes they occur in connection with scars (cheloids)   *Neurofibromatosis* is a form of multiple fibroma occurring in relation to the nerves of the skin or, more rarely, the internal organs   The name of Recklinghausen's disease is often given to the condition   The tumours occur along the course of the nerve trunks, and show, as a rule, the structure of soft fibromas   Sarcomatous change may occur in them, especially in the deeper seated varieties   Tumours of the medullary portion of the suprarenal glands as well as pigmentation of the skin are sometimes associated with the disease   *Xanthoma* is a small brownish yellow tumour, often multiple, which occurs chiefly in the eyelid   It may be congenital, but more often develops late in life, some times in association with jaundice and diabetes   There is a difference of opinion as to the exact nature of the con dition, but it would appear to be a fibrous tissue formation with storage of lipoid material in the cells

Appearance —Usually a well defined rounded or lobulated and encapsuled nodule, soft or hard, firm in consistence, pink or white, the softer type tending to be pink, from its greater vascularity   The cut surface sometimes has a watered silk

appearance. Degenerative changes, such as myxomatous, oedematous, calcareous, are sometimes met with

Microscopically, the appearances are those of ordinary connective tissue Sometimes the cells predominate, at other times the intercellular material, according as the tumour is of the hard or soft variety The cells are usually spindle shaped, *but in the more cellular types may be rounded* The inter cellular material consists of wavy collagenous fibres, staining deep red with eosin and with acid fuchsin.

Tumours composed of Myxomatous Tissue

Myxoma.—This is a somewhat rare tumour composed of mucoid or myxomatous tissue, an embryonic form of con nective tissue The umbilical cord is largely composed of such tissue Certain connective tissue tumours—fibromata, fibro-myomata, chondromata—are not infrequently in part composed of myxomatous tissue When occurring in relation to tumours composed of more adult tissue, the change is regarded as a degenerative one

Sites—Such tumours may be found in any of the *sites* in which fibromata occur, most commonly in subcutaneous and submucous tissue Not infrequently such growths show a *tendency to diffuse* themselves and invade surrounding structures, such are to be regarded as sarcomata. The placental or hydatid mole is often classified as a myxoma (myxoma of the chorion, p. 340).

Appearance—Very soft and gelatinous, not infrequently the material when manipulated forming long strings Trans-lucent, sometimes with minute hæmorrhages

Microscopically, the growth is found to be made up of rounded, spindle shaped and branching cells, widely separated from one another The material between the cells is homo-geneous or slightly fibrillated, and usually stains very faintly Vessels are of course present and hæmorrhages may be found.

Tumours composed of Fatty Tissue

Lipoma —*Sites* —Subcutaneous tissue, especially parts liable to pressure, *e g* shoulders, buttocks, wall of large bowel, kidney, rarely brain.

Appearance —Such tumours vary much in size, may be very minute, occasionally very large, are usually lobulated, and resemble fatty tissue

Microscopically, they consist of adipose tissue with bands of supporting fibrous tissue carrying blood vessels   All stages in development of fat cell are found from fibrous tissue cell, with minute globule of fat, up to cell with merely thin rim of protoplasm and nucleus pressed aside by large fat globule. Crystals of fatty acids are often present in the cells

Tumours composed of Cartilage

Chondroma. —A tumour composed of cartilage either hyaline or fibro-cartilage

Sites —It is occasionally found growing from cartilage of rib or larynx (ecchondroma) more usually in relation to bone or in the interior of glands such as parotid, testicle (enchondroma)   One of the commonest sites is the periosteum of long bones, especially at the ends of the metacarpals and phalanges

Appearance —It is a rounded or lobulated tumour, firm and elastic, surrounded with a fibrous capsule which sends in trabeculæ between the lobules   Not infrequently it shows calcification or soft areas of myxomatous degeneration

Microscopically, the tumour is found to consist of lobules of cartilaginous material composed of rounded or branched cartilage cells lying in spaces between which is a matrix, sometimes homogeneous, at other times fibrillated, occasionally myxomatous   Calcified areas which take on the hæmatoxylin stain deeply are not infrequently met with.   The tumour is surrounded with a connective tissue capsule carrying blood vessels, prolongations of which dip down between the lobules

Tumours composed of Bone

Osteoma—Two varieties are distinguished (1) the compact or ebunated ivory exostosis found in connection with the bones of the skull, (2) the spongy osteoma, in which the bony trabeculæ are thinner and more widely separated The exostoses found in connection with the attachment of muscles are probably not true tumours They are more of the nature of hypertrophies of bony tissue, i e ossification following trauma or irritation

Tumours composed of Muscle

Myoma—Two varieties are distinguished (1) the *rhabdomyoma* or tumour composed of striped muscle fibres, which is very rare, usually congenital and commonly malignant (sarcomatous) It is found in the kidney and testicle, and is due to inclusion of portions of the lumbar muscles (2) *Leiomyoma*, a very common tumour composed of non striped muscle fibres

Sites—Leiomyomata are found by far most frequently growing in the wall of the uterus They may also occur in other positions where non-striped muscle is found, such as the alimentary tract, more especially the œsophagus, also bladder and prostate

Appearance—In the uterus the tumours are frequently multiple They vary greatly in size, from something just visible by the unaided eye to a tumour the size of a fœtal head They are most frequent in the body of the uterus but also occur in the cervix

Three varieties are distinguished according to the position in the uterine wall, viz (1) intramural, (2) subserous, when projecting into the peritoneal cavity and covered with peritoneum over the greater part of its surface, (3) submucous, when projecting into the cavity of the uterus (Fig 104).

The tumours are rounded and well defined from the neighbouring muscle On the cut surface they are usually pink in colour and show an appearance like watered silk or balls of cotton Degenerative changes are common in myomata, *e g* myxomatous change, calcification and a necrotic change known as " red softening "

Microscopic Appearance —The tumour does not differ in any essential respect from the normal uterine wall tissue. It is composed of bundles of (1) non striped muscle fibres running in all directions and therefore in sections cut sometimes longitudinally, sometimes obliquely, sometimes transversely, (2) fibrous tissue running between the bundles and between the individual fibres. So markedly does this fibrous element enter into the composition of the tumour that the term " fibromyoma " is often employed In the myomata found in the œsophagus the amount of fibrous tissue is much less The individual muscle fibres when cut longitudinally are elongated often sinuous structures with similarly elongated nuclei The fibrous tissue often shows degenerative changes (1)myxomatous, (2) hyaline, (3) calcareous Blood vessels with well-developed walls are always present Sometimes gland acini are scattered through the fibro-muscular tumour (adeno-myoma)

Tumours composed of Vascular Tissue

Angioma —Two primary varieties may be distinguished, viz (1) hæmangioma, (2) lymphangioma , a further sub division of each variety into (a) plexiform or capillary, and (b) cavernous may be made

Sites and Appearance —*Hæmangiomata* are most usually found in relation to skin or mucous membrane They may be merely areas of purple colour, the so-called ' port wine stains," or they may project and may even be pendulous They are always dark red in colour and are often pulsatile These cutaneous angiomata most usually belong to the plexiform variety, but may be cavernous The cavernous type is most common in the liver, but may occur in relation to the

membranes of the brain and in the skin It appears as a dark purple area, more or less wedge shaped, immediately under the capsule of the organ (Fig 76) The condition is much more common in the ox than in man *Lymphangiomata* are found in relation to skin and tongue They are probably always congenital and mostly belong to the cavernous type

Microscopic Appearances —(1) *Capillary Angioma* —Instead of the dense fibrous tissue of the cutis, great numbers of minute spaces lined with fairly large endothelial cells are found Some of these spaces contain blood, others are empty Between the cap llaries there is more or less loose connective tissue.

(2) *Cavernous Angioma* —In this type, large spaces are found lined with spindle-shaped endothelial cells and filled with blood, sometimes with thrombi The walls of the spaces are formed of well-developed fibrous tissue

Tumours composed of Lymphoid Tissue

Lymphoma —A simple lymphoma is a rare tumour, usually small and solitary Microscopically, it has the appearance of normal lymphoid tissue, having a capsule, and a reticulum in which are large numbers of lymphocytes also endothelial cells The condition is very difficult to distinguish from mere hypertrophy of lymphoid tissue The malignant type, lymphosarcoma, is more common and much more important.

Tumours composed of Neuroglia

Glioma —Such tumours, arising as they do from the neuroblast, are epiblastic in origin

Sites —They are found in the brain, retina and spinal cord

Appearance —As a rule they are not well defined, but merge into the surrounding brain substance They vary much in size, may be opaque or translucent, white or pink.

A slow growing, simple type is recognised, but many of them have the characters of malignant growths and may be called glio sarcomata (see p 313)   Hæmorrhages frequently occur into their substance

Microscopically, such tumours are formed of small round cells with branching prolongations (spider cells) the latter forming a felted meshwork between the cells   In the case of the retinal glioma, the branching processes may be absent   Vessels are present which are often thin walled and may rupture, leading to hæmorrhages

Epithelial Tumours

Such tumours, in addition to their epithelial elements, always possess a greater or smaller amount of supporting fibrous tissue stroma

1 Papilloma.—This is a tumour projecting from an epithelium-covered surface, composed of connective tissue and epithelial cells   Two types, (*a*) squamous papilloma and (*b*) mucous papilloma, may be distinguished according to the type of epithelial surface from which the tumour grows

(*a*) *Squamous papillomata*—*Sites*—These are found in relation to skin, mouth, larynx, pharynx, œsophagus or vagina

Appearance—They consist of a series of projections composed of a connective tissue core carrying blood vessels and a covering of squamous epithelium   The epithelium is frequently much thickened and the dead material tends to accumulate between the prolongations   The skin papilloma or ordinary wart is sometimes congenital   It is commonest in childhood and is often infective, being probably due to some micro-organism   One of the infective papillomata, the venereal wart, is found in relation to the genitals   Some are due to the irritation of chemicals, such as paraffin   *Molluscum contagiosum* is a condition appearing as small red elevations, affecting more especially the skin

of the head, face and hands The elevations break down in the centre and discharge a cheesy material. The disease is regarded as being due to some germ not yet discovered

Microscopic Appearances —The connective tissue core containing vessels is seen in places in connection with the cutis. In other places there are isolated rounded areas of fibrous tissue produced by the cutting transversely of one of the finger like processes Upon this connective tissue is placed the epithelium which corresponds to the stratified epithelium of the skin and like it shows differentiation into layers The epithelium shows a sharp line of demarkation from the subjacent connective tissue Occasionally whorl like masses of cornified epithelium are seen simulating the "cell nests" of cancers, but these are buried in the thick layer of epithelium and do not penetrate the fibrous stroma.

(*b*) *Mucous papillomata* —*Sites* —These may grow from any mucous membrane—alimentary canal, bile ducts, bladder, pelvis of kidney Some of these are undoubtedly due to organisms, viz. the condition known as coccidiosis, which is a papillomatous condition of the bile ducts, found specially in the rabbit, due to a protozoon—the coccidium oviforme. A somewhat similar condition in the stomach of the rat is due to the presence of a small nematode

Appearance —In structure the mucous papilloma consists of a slender connective tissue core carrying blood vessels, and covered by a layer of epithelium which may be columnar, cubical or transitional, according to the site One of the commonest sites for this type is the bladder, where the growth consists of numerous delicate processes forming a sea-anemone-like mass

Microscopic Appearances —A connective tissue core of great delicacy, carrying blood vessels, dividing and again dividing, is seen in connection with the submucous coat of the viscus if the section be accurately through the root of the tumour Many of the branches are, however, cut transversely Upon this connective tissue core is placed the epithelium

which may be transitional (in the case of the bladder) showing numerous layers of elongated epithelial cells tending to
become loosened and to separate in the more superficial
layers. In the case of the intestinal and bile duct papilloma
the epithelial cells are columnar. Mitotic figures are often
numerous in the cells of the villous papilloma of the bladder

2 Adenoma is the term applied to a *simple tumour composed of gland elements* Such tumours contain, in addition
to the epithelial gland cells, a larger or smaller amount of
supporting fibrous tissue. In this connective tissue the
nutrient vessels run When the fibrous tissue is large in
amount, the term *fibro-adenoma* is used Often the gland
acini in the tumour become dilated (*cystic adenoma*)
Occasionally (breast and ovarian adenomata) within the
cysts there is a papillomatous development of the epithelial
elements supported by fibrous tissue (*papilliferous cystic
adenoma*) Such tumours are generally regarded as being of
doubtful simplicity

Sites —Any gland may be the site of origin of an adenoma
The commonest site for such tumours is undoubtedly the
mammary gland The prostate, thyroid, liver and other
glands may be the seats of similar tumours

Appearance — Such tumours are round or lobulated,
vary much in size, and are surrounded by a fibrous capsule
so that they are readily shelled out The colour is white or
pink, and on section minute clear foci representing groups
of gland acini may be seen Cysts are often present
Another common site for adenomata is the ovary, forming
the so-called compound cystic adenoma The cysts are
often very large and contain mucinous material

Microscopically, the essential parts of the tumour are (1)
gland acini lined with epithelium, resembling that of the gland
from which the tumour arises set upon a basement membrane
Secretion may be present, colloid material in the case of
tumours of the thyroid gland, mucinous material in the

compound cystic ovarian tumour The acini are not infrequently dilated, forming cysts of various size Intracystic papillomatous projections also covered with epithelium may be found, and in the case of the breast tumours small rounded masses of fibrous tissue, the so-called *intracanalicular fibromata* The epithelium in the case of the ovarian tumours is markedly columnar in type.

(2) Fibrous supporting tissue, which varies much in amount, sometimes, in the case of the fibro-adenomata, occurring in large bands which separate the groups of gland acini widely from one another Running in this connective tissue stroma *are the blood vessels of the tumour, as a rule, well developed.*

B MALIGNANT TUMOURS

The general characters of malignant growths and the points wherein they differ from the simple tumour have already been discussed The chief characteristic of such growths is the tendency to *invade* normal structures, so that they *infiltrate* the tissues in which they arise and tend to erode blood and lymph vessels, and to pass by these in the form of tumour emboli to other parts of the body

The term cancer is sometimes used generically for such growths, but the pathologist usually reserves that term for the epithelial type of malignant growth

Microscopically, the malignant tumour is characterised by an *imperfect repetition of the normal tissues* Whereas the simple growth resembles, in many cases very closely, the normal adult tissue from which it arises, the malignant tumour shows considerable deviation from the homologous normal tissue It tends to resemble in many instances the embryonic *type* of the tissue. Hence the use of the term "atypical" in relation to them

Just as simple tumours may be divided primarily into (1) those arising from and composed of connective tissue and (2) those arising from and partly composed of epithelial tissue, so in the case of the malignant growths we may distinguish

a connective tissue and an epithelial group The former
are *sarcomata,* the latter *carcinomata* or true cancers.

SARCOMATA

These are tumours which are *essentially cellular, i.e
contain a minimal amount of intercellular material* The cells
are of the connective tissue type and are embryonic, *i e*
imperfectly differentiated So that what appears to be the
most advanced stage of development of which the tumour
cells are capable corresponds with an early stage in the
development of a fibrous tissue cell from the primitive round
connective tissue corpuscle

Under normal circumstances, either during development
or in the course of the laying down of new tissue in the
process of healing, the connective tissue corpuscle passes
from a small round cell with small round, relatively large,
nucleus and small amount of protoplasm to the large round
cell with abundant protoplasm The cell then becomes oval
and eventually spindle shaped Subsequently from the
protoplasm there are split off collagenous fibrils which form
the intercellular material

In this type of growth the cell which has taken on tumour
characters may stop at any one of these stages and subse
quently reproduce cells of a similar stage of development
and no other type Seldom does it occur that the fully-
developed type of connective tissue cell is found in the
sarcomata It is usually the more primitive types which are
found Occasionally a tumour which shows a high degree
of differentiation may on recurring exhibit a differentiation
of a less high degree Thus a tumour with the characters of
a fibroma may on recurring (recurrent fibroid) assume the
characters of a sarcoma

As the name *sarcoma* indicates, such tumours are flesh-
'like As a rule they form 'large masses of opaque white or

faintly pink material   Necrotic areas are not infrequently present, and hæmorrhages are very common   Certain types are very vascular (angiosarcomata) and some develop pigment (melanotic sarcomata)

In consistence sarcomata are commonly soft, sometimes diffluent, and often show areas of more marked softening They are, however, sometimes firm and may even be hard Like other forms of malignant growth, they show a marked tendency to infiltrate and thus are seldom encapsuled

Although, as already stated, they tend to stop short of the fully-developed form of the connective tissue from which they arise, such tumours not infrequently reach a fair degree of differentiation of tissue   Thus those arising from cartilage tend to produce cartilage, those arising from bone produce bone-like tissue, those arising from muscle may produce muscle cells, and so on   This differentiation forms a basis for classification   Hence we speak of chondro-sarcomata, osteo-sarcomata, etc   A majority of these tumours, however, merely exhibit various stages of development of the connective tissue cell   In order to classify them we use such terms as small round cell sarcoma, large round cell sarcoma, small spindle cell sarcoma, large spindle cell, fibro-sarcoma, mixed cell sarcoma

As a rule, the less differentiated the type of cell composing the tumour the more malignant it is   Thus the small round cell sarcoma is one of the most malignant types   Sometimes a tumour starts by being simple but becomes malignant, either a portion of the growth assuming the malignant type, or the whole tumour, as in the so-called recurrent fibroid, becoming more and more malignant at each recurrence   This prepares one for the fact that *there are degrees of malignancy*

Sarcomata very commonly produce metastases   Such metastatic growths are found not so frequently in lymph glands as in the internal organs   Hence the statement that these tumours spread more by the blood than by the lymph

channels   This is true up to a certain point, but there are exceptions, particularly in the case of the melanotic tumour which often spreads by the lymphatics

As regards *sites of origin*, such growths may arise in any part of the body in which connective tissue is found, and this means anywhere at all   There are, however, certain parts and tissues more commonly affected than others   Thus, subcutaneous tissue, intermuscular septa, fasciae, periosteum, bone, lymph glands are common sites of origin   As regards the secondary deposits, these occur more commonly in the lung than in any other organ (see p 186)

Types of Sarcomata

Small Round Cell Sarcoma —This is a white, grey or pink, soft, sometimes diffluent tumour, found primarily in connection with subcutaneous tissue, bone, muscles, brain testicle, and secondarily anywhere, but most commonly in the lungs   Hæmorrhages and areas of necrosis are frequent The tumour is one of the most malignant types known

Microscopically, such tumours are composed of small round cells closely packed, with scanty protoplasm and small dark staining nuclei   The cells resemble very closely the lymphocyte of the blood and lymph glands   The intercellular material is scanty, granular or slightly fibrillated   The vessels are thin walled, often consisting of a single layer of cells Hæmorrhages and areas of necrosis are frequent.

The so-called **Lymphosarcoma** may be regarded as a subvariety of the above   It originates in lymphoid tissue, very commonly in the lymphatic glands of the mediastinum, and is very malignant   In appearance it resembles other types of sarcoma (Fig 56)

Microscopically, such tumours are composed in large part of small round lymphocyte like cells with rather more intercellular material than in the case of the ordinary type of small round

cell sarcoma There is often a fair number of larger flattened or polygonal cells, representing the endothelial elements of lymphoid tissue. Occasionally this larger type of cell is the predominant one (endothelioma)

Large Round Cell Sarcoma.—These tumours have much the same appearance as the above, but tend to be on the whole firmer in consistence The sites of origin are also much the same, but the testicle, pharynx and posterior nares and muscle are perhaps more commonly affected

Microscopically, as in the previous type, the tumour is composed essentially of cells, but there is more intercellular material, and the fibrils of which it is composed are thicker The cells are of course larger, rounded or polygonal with more abundant protoplasm and a nucleus with a wider-meshed network, hence staining less deeply Areas of necrosis and hæmorrhages are common The vessels are better developed. Sometimes the cells have an alveolar arrangement

Small Spindle Cell Sarcoma. — Such tumours resemble the preceding but are more benign

Microscopically, the tumour is composed of small oat shaped cells arranged irregularly in bundles The cells represent a further stage in the development of the connective tissue corpuscle. The vessels are, however, still very imperfectly formed

Large Spindle Cell Sarcoma —In this type the fas circulation may be visible to the naked eye The tumour bears considerable resemblance to a fibroma It is, moreover, firmer than most other types Such tumours occur in relation to periosteum, muscles, mamma, or ovary

Microscopically, the cells are arranged in bundles There is a considerable amount of intercellular fibrillated material, and the vessels are fairly well supported It is difficult in many instances to differentiate such growths from cellular fibromata The cells tend, however, to be larger and to vary more in size, and mitotic figures are often present

From the microscopic point of view it is *a matter of great difficulty* in many instances, especially when only a minute portion of tissue is available, *to differentiate giant tumours from granulation tissue* Nothing less than long experience will enable the pathologist to do this in many cases The point to attend to is the uniformity of type in the cells In the case of granulation tissue all stages of development of the fibrous tissue cell will be met with, whereas in the case of the sarcoma the cells tend to be all of one type, round or spindle, as the case may be

Mixed Cell Sarcomata are met with occasionally. In such, in addition to round and spindle cells, giant cells (multinucleated masses of protoplasm) are often found

To this type belongs the **myeloid or giant cell sarcoma** found in relation to bone

Sites —Such tumours occur in young subjects, chiefly in the upper end of the tibia and fibula, the lower end of the femur and in the lower jaw (malignant epulis, Fig 109)

Appearance —These tumours are slow growing and show generally a low degree of malignancy They do not tend to produce metastasis and rarely recur when removed They grow from the interior of the bone, distending and thinning the overlying bony tissue They show the appearances of sarcomata generally, but hæmorrhages are specially frequent.

Microscopically, myeloid sarcomata are usually composed of spindle shaped cells with large multinucleated masses of protoplasm scattered more or less regularly through them. These giant cells are sometimes absent over considerable areas They may be differentiated from the giant cells of tuberculosis by their nuclei occurring all through the cell, especially in the centre, whereas the tubercle giant cell has its nuclei arranged in a zone at the margin Hæmorrhages are frequent

Glio-sarcoma is a type found in the central nervous system and retina It is the malignant analogue of the glioma and resembles it in appearance (see p 313)

Sarcomata sometimes show a greater amount of differentia
tion of tissue Those arising in connection with bone may show
a tendency to form cartilage (chondro sarcoma) or bone
(osteo-sarcoma) or a mixture of the two Such tissue only
imperfectly reproduces the structure of its normal homologue
The cartilage is very irregular and has a marked tendency
to undergo myxomatous change The bony tissue is only
imperfectly formed, the calcareous material being deposited in
rather than combined with the intercellular tissue Necrosis
and hæmorrhage are prominent features of such tumours

Endothelioma —Sites —This is a term of somewhat
indefinite significance applied to tumours occurring in
connection with serous membranes such as the pleura,
peritoneum and dura mater, but also in other parts of the
body in relation to lymph and blood channels and lymph
glands Apparently they may originate in any position
where connective tissue tends to assume a flattened
character in consequence of forming a lining to a channel,
space or cavity

Appearance —Such tumours have the characters and
appearances of sarcomata in general

Microscopically, the chief characteristic is a tendency for the
cells to group themselves so as to form rounded or irregularly
shaped spaces into which the flattened or polygonal cells pro-
ject Owing to the above-mentioned microscopic appearances
the term *alveolar sarcoma* is often applied to these tumours

Perithelioma is a term applied to a neoplasm in which
there is whorl like arrangement of the constituent cells
round a central blood or lymph space, the cells being of a
flattened or polygonal shape Such tumours are found,
specially in the central nervous system, growing from the
membranes of the brain or cord Sometimes in the centres
of these whorls of cells instead of a space there may be a
mass of calcareous material. Such tumours have been

called *Psammomata* or " brain sand tumours " They occur
in relation to the cerebral meninges and ventricles

Angiosarcoma.—Closely related to the above are malig-
nant growths in which spaces containing blood are the
principal feature The spaces are lined with endothelial
like cells Such tumours have of course a very vascular
appearance They are not uncommon in the brain, and are
found occasionally in the spleen

Myelomata are tumours which arise from one or other
of the blood forming elements in the bone marrow The
cells composing them are rounded or polygonal and may
resemble the myelocyte, lymphocyte, nucleated red cell or
plasma cell They occur as multiple white masses in the
interior of bones such as sternum, ribs, spinal column, skull,
femur, humerus They destroy and distend the bone,
leading sometimes to spontaneous fracture In the urine a
peculiar form of albumose (Bence-Jones albumose) is some
times found in such cases

MELANOTIC TUMOURS

Melanin pigment occurs normally in the deeper cells of
the *stratum Malpighii* Subjacent to these, in the cutis vera,
are certain spindle-shaped cells which may contain pigment
and which are known as *chromatophore cells* Whether these
cells elaborate the pigment from the blood or bear it to other
destinations from the epithelial cells is uncertain Similar
pigment is also found in the choroid and in the iris The
chemical characters of the pigment vary somewhat according
to the site, but as a rule it contains a considerable quantity
of sulphur and little or no iron In colour, under the micro
scope, the pigment varies from yellow to dark brown To
the naked eye it usually appears almost black

Pigmented Moles—These are congenital melanotic tumours of a simple type which are also sometimes known as "nævi" They are exceedingly common occur on almost any part of the skin surface, and seldom give rise to trouble, although they occasionally become malignant They consist of the enlarged papillæ of the skin, which may project considerably, are usually more or less deeply pigmented with melanin, and may have hairs growing from them

Microscopically, the enlargement of the papillæ is found to be due to collection of epithelioid cells with relatively large pale staining nuclei These are often known as "nævus cells" and their origin is a much debated point. Some regard them as rounded chromatophore cells, others as cells of epithelial nature. They contain melanin pigment in varying amount, and masses of similar pigment are also found outside the cell groups The use of the term nævus is perhaps unfortunate in view of the employment of that term for angiomas of the skin But there is no very clear line between the two types of growth, the pigmented moles sometimes showing blood channels.

MELANOTIC SARCOMATA AND CARCINOMATA

The exact position from the point of view of classification of many of these melanotic tumours is uncertain Some have the microscopic characters of sarcomata of the spindle cell type In others the cells are polygonal, and others again have the appearance of epitheliomata Pigmented mesoblastic cells are found in the choroid and iris, and, as we have seen, cells resembling connective-tissue corpuscles (chromatophore cells) are found in the cutis, but whether these latter form the origin of melanotic tumours is uncertain The pigment-containing cells in the pigmented moles are also of uncertain nature Many of these melanotic tumours probably arise from the cells in the deeper layers of the stratum Malpighii, and are therefore of epithelial origin and should be classified with the carcinomata

Sites—Tumours which contain melanin are met with primarily in connection with the *skin* (particularly in relation to pigmented moles) and with the *eye*   Secondary deposits occur specially in *lymphatic glands* and in the *liver* Such tumours, as a rule, are exceedingly malignant in the sense that secondary growths may occur early when the primary tumour is minute

Appearance—The appearance of such tumours is very characteristic owing to the presence of the melanin, which imparts a dark brown to black colour to the growth   The pigment may, however, be present only in parts, the pigment-free areas having the appearance of an ordinary sarcoma The student should be careful not to fall into the error of calling a neoplasm in the lung, where carbon pigment is normally present, melanotic.

Microscopically, such tumours, as already stated, vary considerably   The cells may be spindle shaped, polygonal or epithelioid.   The pigment is present within the cells and in masses outside.   Considerable areas of the tumour may have no pigment present at all   The pigment is yellow to dark brown in colour and is exceedingly resistant to reagents of all kinds. For its demonstration sections of the tumour should be stained in the nuclear dye (*e g* hæmatein) only   The cells often have an alveolar arrangement.

Pigment of a yellow, brown, or black appearance occurs in tumours other than melanotic growths   Attention has already been drawn to the fact that tumours of the lung and mediastinum inevitably show pigmented areas of a black colour due to carbon   Tumours with old hæmorrhagic foci in them are likewise pigmented   The pigment is yellow or brown in colour due to deposit of hæmatoidin   There is little likelihood of the student mistaking these for melanotic growths except under the microscope, as the pigment is small in amount and localised in the neighbourhood of the hæmorrhage   It should be noted further that the pigment resulting from hæmorrhage is lighter in colour, yellow

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rather than dark brown, and it is sometimes in the form of acicular crystals, whereas melanin pigment is always amorphous

CARCINOMATA OR CANCERS

These are malignant tumours, the essential constituent of which is epithelium In addition to the epithelium there is always a greater or smaller amount of *connective tissue stroma*, which supports the epithelial elements and in which run the nutrient vessels This stroma is derived in part from the pre-existing tissue of the area in which the tumour occurs, to a much greater extent it is a new development from the fibrous tissue of the host It is this occurrence of two distinct types of tissue—epithelial elements and supporting connective tissue scaffolding—which distinguishes this type of malignant growth from the sarcomata In the case of the latter the cells tend to be all of one type and are diffusely arranged

Inasmuch as there are two main types of epithelium— (1) the stratified squamous type, covering skin and lining mouth and œsophagus, (2) the glandular type, covering the intestine and forming the secreting elements of glands—so there are two main types of carcinomata (1) Squamous epitheliomata, (2) Adeno-carcinomata

The characters of these tumours are those of malignant growths in general The main underlying property is that of *invasion of the normal tissues* Sometimes, in the case of a tumour of a surface such as the skin or of a lining membrane of a viscus such as the bowel, enlargement may take place mainly by projection of the growth Such an appearance often receives the name 'fungating' tumour (Fig 69) As a rule, however, the tumour grows chiefly by penetrating the healthy tissues around

When growing on one of the surfaces—skin or bowel— *ulceration* of the growth very soon occurs This leads to

invasion of organisms and absorption of toxins an important
factor in the production of the cachexia of cancer

The erosion of the tissues by the cancer cell elements
leads to *invasion of lymph and blood-vessels* It is chiefly by
the former that carcinomata spread, so that the secondary
deposits are to be sought for first of all in the nearest
lymphatic glands Spread may also occur *by way of the
blood-stream*, secondary foci occurring in the internal organs
such as liver and lungs

  This invasion by the cancer cells is resented by the normal
tissues, with the result that an *inflammatory reaction of a
subacute type occurs in the tissues at the growing margins* of
such growths This inflammatory reaction manifests itself
by an infiltration of the tissues with small round cells similar
in appearance to the lymphocytes of the blood but in reality
of diverse origin

  The *metastases resemble as a rule the primary growth fairly
closely* They show the same division into epithelial elements
and supporting fibrous tissue The tendency is, however,
for the epithelial elements to show less marked differentiation
Thus in squamous epitheliomata the secondary deposits
may show little or no tendency to cornification and formation
of cell nests

  The *cancer cells* themselves vary greatly in shape and
appearance As a rule they tend to be larger than their
normal homologues They may show evidence of secretory
activity when they arise from glandular epithelium This is
indicated by vacuolation of the cells and by the accumulation
of mucinous or colloid material in the gland spaces *They
do not preserve the normal relationship with their surroundings*
Thus the groups of gland cells have no basement membrane
Instead of the normal single layer of cells forming an acinus
there are often several layers

  Mitotic figures are often numerous, their number being
taken as a measure of the rapidity of the growth of the tumour

The figures are frequently abnormal, showing multipolar division The chromosomes are more often heterotypical (*i e* rounded instead of V-shaped—a condition characteristic of the stage of maturation of the sexual cells) than is the case in the cell dividing normally

Various forms of *inclusions* are commonly met with in the cancer cells These are known as "cancer bodies," and have from time to time been taken as representing parasites of various types They are produced by the phagocytic activity of the cells taking up leucocytes, other cancer cells, red blood corpuscles, etc They appear as rounded bodies, usually with a distinct space surrounding them Other bodies occurring mainly between the cells, usually in groups, are found They are known as Russell s fuchsin bodies, and probably represent hyaline degenerations of cells or segregations of albuminous material

Carcinomata occur (1) at or near the orifices of the body—lip, tongue, rectum, vagina, (2) at points where normally there is narrowing of a canal—pylorus, ileo cæcal valve, (3) at points where a canal changes its direction—hepatic, splenic, sigmoid flexures of large intestine, (4) in glands such as the mammary, and in organs such as the uterus, which are periodically undergoing hypertrophy and involution In other words, there is a marked association of cancer with chronic irritation of various kinds

The tumours commonly grow from a single centre The various prolongations of the growth will be found all to radiate from a single point

As previously indicated, carcinomata may be divided into two main groups—(1) *Squamous epitheliomata*, (2) *Adeno carcinomata or glandular cancers*

I. Squamous Epitheliomata

Sites—These grow from (*a*) the skin, (*b*) mucous membranes covered with stratified squamous epithelium, such as mouth,

*œsophagus, vagina, cervix uteri , (c) embryonic epithelial canals,
such as the thyro glossal duct*   Occasionally they occur where
no squamous epithelium is found normally, *e g* in stomach
and gall bladder

Appearances —Such tumours occasionally project beyond
the general surface, forming a fungating mass   More com
monly they appear as *ulcerated areas the margins of the ulcer
being raised and hard* (Fig 57)   On cutting down through the
floor of the ulcer so that the relationship with the subjacent
tissues is displayed, the opaque white epithelium will be found
penetrating the tissue for a variable distance

Microscopically, such tumours are found to be formed of
tongue like prolongations of epithelium   Sometimes these can
be traced in continuity with the original mass, at other times
they are cut transversely and appear as isolated rounded
masses   At the spreading margin and in the early stage of
the condition these columns of epithelial cells, being only a
few cells thick, show no differentiation into layers   In the
larger masses the central cells become flattened and undergo
a change similar to the keratinisation of the stratum corneum
When the columns are cut transversely the appearance is that
of a central whorl of flattened cells concentrically arranged,
representing the stratum corneum and surrounded by the poly
gonal epithel al cells representing the cells of the stratum
Malpighii, and like them showing intercellular bridges   This
appearance is known as a "cell nest."   These cell nests must
be distinguished from hair follicles and other normal structures.

The cells forming these epithelial down growths resemble
the normal cells found in the deeper layers of the stratum
Malpighii   They tend, however, to be somewhat larger than
their normal homologue   Mitotic figures are usually to be
found amongst their nuclei, sometimes in large numbers.

Between these columns of epithelial cells are the tissues
—muscle, connective tissue, glandular structures—which have
been invaded by the growth   These are infiltrated by small
round cells   These cells are specially well seen at the growing
margin of the tumour, the appearance being known as small
round cell infiltration.   Such small round cells may be

lymphocytes *from the blood or young connective tissue cells.* Hæmorrhages are not uncommonly met with in the marginal portions of the growth In addition to the pre-existing tissues of the part there are strands of newly formed connective tissue between the masses of epithelium These constitute the scaffolding of the new growth, and are composed of *granula tion tissue, with a large proportion of small round cells*

Rodent Ulcer.—This is a variety of squamous epithelioma with a low degree of malignancy

Site—The condition occurs in old people on any part of the skin, but most frequently on the upper part of the face, about the root of the nose, the external angle of orbit, the side of the cheek and the forehead

Appearance—It appears as an ulcerated area with raised margins, which erodes down to the bone and may destroy the nose or ear, but which does not produce metastases and is very amenable to treatment. The tumour is believed to originate from the hair follicles or sweat glands, rather than from the epithelium proper

Microscopically, the condition is characterised by the presence of masses of epithelial cells penetrating the subjacent tissues There are certain points of distinction between this and the ordinary squamous epithelioma. (1) The cells are cylindrical or spindle shaped, and are as a rule smaller than those found in the epithelioma. (2) There are no cell nests or only imperfect attempts at keratinisation in the centres of the epithelial masses (3) There is little or no evidence of cell reaction (round-cell infiltration) in the tissues which are being invaded (4) The line between epithelial masses and fibrous stroma is sharply marked.

II. Adeno-Carcinomata, Malignant Adenomata, or Glandular Cancers

These tumours are composed of gland cells arranged in alveoli or in solid masses and of intervening supporting fibrous tissue This stroma is often absent at the spreading margin

of the growth, the gland cells occurring in and between the
tissue elements of the part

As stated above, the epithelial elements show two fairly
well marked types of arrangement They may occur *in
acini, i e* with an arrangement of the cells similar to what is
found in most normal glands, the epithelial elements lining
a space, or, on the other hand, they may occur *in solid
masses* In the first type the cells tend to be columnar, in
the second type from mutual pressure they assume a rounded
or spheroidal form This difference in the shape of the
cancer cells is usually taken as a basis for further division
into two types, viz   (1) *Columnar cell carcinoma*, and
(2) *Spheroidal cell carcinoma*   By some authorities the
term adeno carcinoma is used exclusively for the first type

There are other types of carcinomata occurring in certain
glandular organs, the cells of which are arranged not in acini
but in columns   This arrangement obtains in the liver, and
in glandular cancer of that organ the columnar structure
may be reproduced

Occasionally a tumour may show an acinous arrangement
in one part and in another the cells may be massed together
At the same time the tumours of the two types preserve their
characters with a fair degree of constancy It should be
noted that the terms adeno-carcinoma and malignant
adenoma are often reserved for acinous cancers, and are
therefore synonymous with columnar cell carcinomas

1 Columnar Cell Carcinoma —*Sites* —These tumours
are found most frequently in the stomach and the intestinal
tract   They are also found in the liver, pancreas, uterus,
mammary gland, etc

Appearance—They may occur as projecting fungating
masses (Fig 69), or merely as ulcerated surfaces with
infiltration and thickening of the walls of the gut There is
commonly annular contraction of the gut at the affected
point. Secondary deposits are common in the nearest

lymph glands and in the liver Such secondary growths
have a very variable appearance

Microscopically, these tumours are mainly characterised by
a downward growth of the gland elements into the wall of the
viscus, so that gland acini are present in the submucous and
muscular layers At the same time the cancerous epithelium
differs from the normal The cells tend to be larger, they
vary somewhat in size and shape They possess no basement
membrane Mitotic figures may be found in considerable
numbers There is a tendency to form several layers of
epithelium instead of one, and sometimes there is no lumen
present owing to the multiplication of the gland cells There
is an inflammatory infiltration of the normal tissues at the
spreading margin of the growth Where the tumour is pro-
jecting into the lumen of the gut, also when it occurs as large
solid masses in organs such as the liver, also in the secondary
deposits in glands, a stroma of connective tissue forms which
carries the nutrient blood vessels.

2 Spheroidal Cell Carcinomata —These tumours are
commoner in certain situations, *e g* breast, but they may
occur anywhere It has been customary for long to distin-
guish them according to their physical characters into
Scirrhous or hard cancers, and *Encephaloid or soft cancers*
Such names are still in use, and although the distinction
depends merely upon the relative preponderance of fibrous
tissue and cancer cells, it is convenient to describe them
under these headings

(a) Scirrhous Cancer —Sites —This is found most typically
in the breast, although it also occurs in stomach, intestine,
pleura, ovary

Appearance —Such tumours are opaque white, tendinous-
looking masses radiating into the surrounding parts (Fig 103)
They are very hard, and creak on being cut Opaque yellow
areas of necrotic change are sometimes visible, although
these are not nearly so numerous as in the encephaloid type
In the case of the breast there is very commonly indrawing

of the nipple   The cut surface often becomes depressed and cup shaped

Microscopically, the tumour shows a large preponderance of the fibrous stroma element   This connective tissue in the more central parts is well developed and shows few cells.   At the growing margin it is more cellular   In this fibrous stroma are elliptical spaces filled with cancer cells   The cancer cells themselves are spheroidal from mutual pressure, and there is often a space (artificially produced by shrinkage) between them and the fibrous stroma.   Mitotic figures may be found   No basement membrane is present.   In the centre of the growth the groups of cancer cells may be few and far between   At the growing margin they are more numerous   Occasionally there may be attempts at the formation of a lumen.

(*b*) Encephaloid, Medullary or Soft Cancer —*Sites* —They occur in sites such as the breast, stomach and pancreas

Appearance —The tumours in this type tend to be larger, softer, more vascular, and there are more often areas of necrosis

Microscopically, they are characterised by a smaller proportion of fibrous stroma and a larger proportion of glandular epithelium   The cancer cells vary in size, but they occur in much larger masses than in the scirrhous type   Further, necrotic changes are very commonly present amongst them.

3   Colloid Cancer is a special type of Adeno-carcinoma, characterised by the accumulation of mucinous material in the spaces, which becomes inspissated and hence gum like in consistence

Sites —The stomach, large intestine and mammary gland are the common sites for such growths

Appearance —It appears as gelatinous translucent material, in greater or less amount, in the tumour and its secondary deposits   Otherwise the growth has the appearance of a columnar cell carcinoma.

Microscopically, these tumours often show in parts the characters of the ordinary columnar cell carcinoma. In other parts, the gland acini are dilated and the lumen filled with homogeneous or slightly fibrillated material. *The cells are often vacuolated from the presence of secretion. They become detached from the fibrous stroma and eventually disappear altogether, fusing with the mucinous contents of the spaces*

C TERATOMATA

There remains for consideration a number of tumour formations traceable to some defect in the development of the individual, also others due to the grafting of the embryo's tissues upon the maternal organism

To the first group belongs the **Teratoma** properly so called *or Dermoid Cyst*

Such tumours are, as their name indicates, usually found in the form of cysts. The cyst wall is developed from the tissues of the host. The wall is lined by skin epithelium and encloses chiefly soapy looking material and hairs, frequently also teeth, skin, bone, cartilage, muscle, nerve elements it may be, and rudimentary viscera. The causation of the condition is, in most cases, the inclusion of the elements of one individual within the body of another. The growth is simple in nature

Site —The site of such tumours is commonly in or near the ovary (Fig 102), but they may also occur in the testicle, the neighbourhood of the sacrum, the side of the neck and face, also very occasionally in the brain

Appearance —The tumour varies much in size. Occasionally it may be as large as a fœtal head. As a rule there is a point, the so-called " protuberance," which represents the head and from which arises a tuft of long hairs

Microscopically, dermo d cysts show a great variety of types of tissue—stratified squamous epithelium sweat glands, hair

follicles, cartilage, bone, gland acini lined by epithelium of various kinds, etc.

To the second group (those due to the grafting of embryo tissues upon the maternal organism) belong (a) the placental mole, or myxoma of the chorion, already described on p 340, and (b) the chorion-epithelioma.

Chorion Epithelioma

This is an exceedingly malignant condition which may follow an abortion or full time pregnancy, also its simple analogue the placental mole

The outer surface of the chorionic villi consists of the layers of epiderm   The most external (syncytium) is formed of multinucleated masses of protoplasm (giant cells)   These possess normally intense phagocytic properties, whereby the villi are enabled to penetrate the maternal tissue and come to lie within the blood sinuses of the uterus   Underneath this layer is a second, in which the cells are separate and do not stain so deeply   This is what is known as the Langhans layer

After an abortion or full time pregnancy the layers of cells covering the chorionic villi may take on abnormal growth , developing into a tumour which is essentially cellular (having no intercellular material), which shows no arrangement of its elements and possesses no blood vessels

Sites —The usual site for such tumours is the uterus, following abortion or full-time pregnancy   Occasionally they occur independently of pregnancy, as for example in the testicle   Such are probably due to germ cells taking on active development and producing a trophoblast (the two layers of cells covering the villi are known as trophoblast) from which the tumour arises

Appearance —Such a tumour appears as a soft spongy vascular mass in the wall of the uterus   Necrosis and hæmorrhage are characteristic features of it.   Metastatic growths

develop very early and are found especially in the lungs, but also in the liver and kidneys

Microscopically, two types of cells are found in the parts of the tumour which are not necrosed   (1) large plasmodial masses, mostly multinucleated, derived from the syncytium, the nuclei of which are in rapid division and show all varieties of abnormal mitoses, (2) groups of smaller, polyhedral cells derived from the Langhans layer   Both types of cell are found in the uterine wall penetrating the tissues and eroding blood vessels

TABLE OF TUMOURS

A. SIMPLE TUMOURS—
    Fibroma, Myxoma, Lipoma, Chondroma, Osteoma, Myoma, Angioma, Lymphoma, Glioma, Papilloma, Adenoma.

B MALIGNANT TUMOURS—
    (*a*) *Sarcomata*—
        Small round celled, Lymphosarcoma, Large round-celled, Small spindle-celled, Large spindle-celled, Mixed celled, Myeloid, Chondro-sarcoma, Osteo sarcoma, Endothelioma, Alveolar, Perithelioma, Angiosarcoma, Myeloma, *Melanotic*

    (*b*) *Carcinomata*—
      I   Squamous Epitheliomata.
        Rodent ulcer
      II Adeno-Carcinomata
        1. Columnar Cell Carcinoma.
        2. Spheroidal Cell Carcinoma.
          Scirrhous, Encephaloid
        3 Colloid Cancer

C TERATOMATA—
    I   Dermoid Cyst.
    II. Embryomata.
        Myxoma of Chorion (simple).
        Chorion Epithelioma (malignant).

CHAPTER XV

POINTS TO BE REMEMBERED IN PERFORMING AUTOPSIES
ON CASES WITH A MEDICO-LEGAL ASPECT

GENERAL METHOD OF PROCEDURE IN
MEDICO-LEGAL CASES

*It must be remembered that all cases of death which have occurred
suddenly or unexpectedly, and cases of death where no medical
man has been in attendance, as well as all cases of death from
violence whether the result of accident, suicide or homicide, are
the subject of inquiry by the authorities—in Scotland the Pro-
curator-fiscal and in England the Coroner—and that in all
cases of the above nature a post mortem should not be made
without instruction from the authorities*

It must also be noted that *in cases of accidental injury to
work-people,* in which death ensues either at the time, or, it
may be, months afterwards, a public inquiry may be held by
the authorities and that therefore *a post mortem should not
be made until the authorities have been communicated with*

In performing a medico legal post mortem, the following
precautions should be exercised

1 The body should, if possible, *be identified by relations
or the police in the presence of the doctor before the post mortem
is commenced*

2 Under *all* circumstances, such a post mortem must be
complete, i e every cavity and organ must be examined

Note—Unless there are special circumstances indicating
its necessity, it is not usual to examine the spinal cord

*3 If there is any suspicion of poisoning the following
tissues should be preserved :—*

<div style="margin-left:2em">

(1) Stomach and its contents

(2) Intestines and their contents

(3) Liver (at least half)

(4) Kidney and spleen

(5) Some blood

(6) Urine

</div>

In special cases it may be advisable to remove other organs,
such as the brain, lungs, etc

*4 All tissues, etc , removed must be placed in glass vessels
which are chemically clean, which should then be made air
tight, sealed and labelled* The label should bear on it the
nature of its contents, and the date of the post mortem, and
should be signed by the doctor

Each tissue or organ should be preserved in a separate
vessel, and no preservative of any sort should be used

In England the inquest held in the coroner's court is
the first step in the legal proceedings under the following
circumstances :—

<div style="margin-left:2em">

(1) All accidental deaths

(2) Homicide

(3) Suicide

(4) Poisoning

(5) Death from anæsthetic

(6) Sudden death under suspicious circumstances

(7) On all persons who die in prison

(8) In all cases in which the practitioner is unable to certify
the cause of death

</div>

An inquest is supposed to be held upon all accident cases
that die within a year and a day of the original injury   A
full post mortem is required in every case   In general,

the coroner has very little power to decide whether an inquest is necessary or not   This decision is already made by law, and while it may lead to numerous inquests and post mortems, it is looked upon as a further safeguard to the public

In larger cities the coroner is always a full time officer, and is usually a physician or a lawyer   In the smaller places it is general to appoint a practitioner, who is paid according to the amount of work done and who does not receive a definite set salary

All evidence, medical or otherwise, is taken under oath and copied down, word for word, at the time of the inquest   This deposition is read over to the witness, and if correct, is signed, and is used again in any further proceedings that may be taken in the higher courts   A medical witness may use clinical and post mortem notes while making his deposition, but they must be his own and made within a reasonable time of the medical examination of the patient   Counsel may be briefed by any of the interested parties medical or otherwise, and certain questions may be put to the witness by leave of the coroner and cross-examination conducted

Legally speaking, the coroner's court is not strictly a trial, because the prisoner or accused, if there be one, cannot be called upon to plead

In Scotland the medical examiner must write a report of the examination in " *soul and conscience* ' *form*

This medical report must contain the following :—

(1) Date and place

(2) State by whom body has been identified

(3) Where the examination was performed

(4) An account of the external appearances

(5) An account of the internal appearances

(6) Conclusion from above as to the cause of death

It is essential that *any alterations should be initialled*, but it is better to rewrite the report if additions or alterations have to be made

No opinions other than the conclusion as to the cause of death should be given in the report

No technical terms should be employed in writing the report　The language used should be as far as possible, popular

The report should be signed by the medical man or men, their medical qualifications being appended

The report is sent to the Procurator Fiscal of the district

POST MORTEM EXAMINATION OF THE FŒTUS

The method of examination of the fœtus differs in several respects from that which has been described in the case of the adult, and the post mortem findings are as a rule very dissimilar from those in the adult　In the fœtus we are in most cases dealing with organs that are free from disease, death being due to injuries received during birth or to diseases affecting the mother and only indirectly causing death of the fœtus by interference with the placental circulation

The routine to be followed varies considerably according to whether we have to deal with a macerated fœtus, that is, one that has died before the onset of labour and has been retained *in utero* for some time, or with one which has died *during* labour from such causes as asphyxia or cerebral hæmorrhage　It cannot be too strongly emphasised that vital information may be obtained in both cases from examination of the placenta

Examination of a Macerated Fœtus

It has been found that syphilis accounts for antenatal death in about one-third of all cases　It is probably the

most frequent single cause of death of the fœtus before
labour   Hence the very fact that a fœtus is born in a
state of maceration should at once arouse suspicion of the
presence of this disease   In order to decide regarding its
presence or absence, attention should be directed to the
following points —

1 *The Liver* —In a syphilitic fœtus the liver is usually pale
yellow in colour, firm in consistence, and may be studded over
with minute greyish spots   A normal liver may weigh in the
fœtus anything up to $\frac{1}{18}$th of the fœtal body weight   If it
weighs more than this it is probably syphilitic, although if it
weighs less it does not by any means exclude syphilis   Thus
a syphilitic fœtal liver may weigh only $\frac{1}{30}$th or even less of the
body weight

2 *The Spleen* —A healthy spleen may weigh as much as
$\frac{1}{150}$th of the body weight   If it weighs more than this it
is probably small, although, as in the case of the liver, a
small spleen does not exclude syphilis   A syphilitic spleen
is, however, more likely to be enlarged than a syphilitic
liver   Its edges are rounded and its consistence firm

3 *The Placenta* —A normal placenta may weigh as much
as $\frac{1}{8}$th of the body weight, that is, may have a weight ratio
of 4 (weight ratio of an organ is the quotient obtained by
dividing the body weight by the weight of the organ)   This,
however, only applies to a placenta of at least eight months'
development   Below the eighth month the weight ratio
rapidly increases, and at the third or fourth month of fœtal
life the weight of the normal placenta may equal that of the
entire fœtus, or even exceed it   Provided, however, that the
fœtus is at the eighth month or later if it has a weight ratio
of over 4 (if the placenta contains no clots which add to its
weight), it is probably syphilitic   The syphilitic placenta,
too, in the case of the macerated fœtus, has characteristic

appearances   It is pale from non vascularity, looks large and heavy, and is thickened from the maternal to the fœtal surface   Microscopically, the appearances are even more characteristic   The villi are enlarged from proliferation of connective tissue, they are non vascular, and, because of the enlargement of the villi, the intervillous space is diminished in extent   It is, of course, this enlargement of the individual villi that leads to the enlargement of the entire placenta

Presence of Spirochætes — The organs should be examined for spirochætes by the dark ground method, or if permanent sections are required, by the Levaditi silver stain   The organisms are found most plentifully in the liver, lung, spleen, kidney, and suprarenal   They are scarcely ever found in the placenta, and it is generally useless to search for them there,   they are somewhat more frequently found in the umbilical cord, especially in the fœtal end of it

If fœtal death is not due to syphilis the above signs are absent.   The liver is small, soft, and dark red in colour   The spleen is not enlarged, and in the placenta the characteristic appearances are absent   It may contain old clots in its substances, and there may be numerous red or white infarcts   These are usually present when the mother suffers from albuminuria, but in this condition there is nothing characteristic in the appearance of the fœtus or its organs   Reliance must be placed chiefly on the maternal history and on the placental appearances

Occasionally the cause of antenatal death may be maternal diabetes, in which the fœtal blood and urine may contain large amounts of sugar   In one case examined recently the percentage of sugar in the fœtal blood equalled that in the mother, viz over 500 mgrm per 100 c cm of blood

Other rare causes of fœtal death may be absence or malformation of organs such as the kidney or brain, abnormalities

of the umbilical cord such as knots, excessive torsion, or localised constrictions, etc. etc

Examination of a Fresh Fœtus

In the fresh fœtus death has occurred during labour, usually from the effects of injuries received during birth The method of examination is similar to that employed in the adult with the exception of the exposure of the cranial contents, which is best carried out as follows —An incision is made from a point slightly above and in front of the ear, across the cranial vault to a corresponding point on the other side and reaching down to the pericranium The flaps so formed are stripped backwards and forwards as far as possible, thus exposing the sutures The cavity is opened by cutting along the sutures with sharp-pointed scissors, care being taken not to injure the brain beneath The frontal and parietal bones on each side are now turned down like the petals of a rose, this being facilitated by notching each bone slightly at its base with the scissors

After the cavity is thus opened, the presence of blood over the upper surfaces of the cerebral hemispheres is sought for Next the dural septa are examined for tears The latter are most frequently present in the tentorium cerebelli, which may be seen by gently raising the occipital lobes of the brain These tentorial tears may be complete, namely involve both layers, or incomplete, involving only one layer, usually the upper Occasionally the tear may be so deep as to extend into the straight sinus, when the fossæ of the skull will be filled with blood These tears of the septa are most likely to be found in cases of breech delivery They may also be present, although less frequently, in the falx cerebri

The brain should now be examined for the *presence of hæmorrhages*, which may be found in the following situations —

(1) Diffusely over the upper surfaces of the cerebral hemi spheres, or there may be localised clots in the same situation

(2) Overlying the corpus callosum

(3) Underlying the temporo sphenoidal lobes

(4) Underneath the occipital lobes, and overlying the tentorium cerebelli

(5) Underneath the tentorium cerebelli, and between it and the cerebellum

(6) Diffusely over the base of the brain—usually in severe injuries, as *e g* to the straight sinus

(7) In one or both lateral ventricles, or more rarely in the third or fourth ventricles

Hæmorrhage in the lateral ventricles is frequently present in premature infants, even when the labour has been easy and natural, and should always be sought for The clot may be of the size of the little finger, distending one or both ventricles

Probably the most frequent cause of death occurring during labour is, however, not cerebral hæmorrhages but *asphyxia* It may arise from prolapse of the cord, from pressure on the cord during breech delivery, or simply from a prolonged second stage of labour leading to paralysis of the respiratory centre The signs to be looked for are as follows :—

(1) *External* Post mortem rigidity is absent, the body is livid, and there may be subconjunctival hæmorrhages

(2) *Internal* There may be excess of fluid in the pleural cavities, subepicardial and subpleural hæmorrhages are frequently, though by no means invariably, found, the blood is fluid and unusually dark in colour, and the organs, especially the liver, are much congested, while the right heart is engorged with dark fluid blood Punctate hæmorrhages may also be found in the thymus, on the upper surface of the diaphragm, and in the parietal pleura

It is important to note that these punctate hæmorrhages *may be entirely absent in cases of asphyxia*

Other causes of death may be found in the abdomen, for example, hæmorrhage into the suprarenal capsule, or underneath the capsule of the liver   Either of these hæmatomata may occasionally rupture into the peritoneal cavity   Very rarely rupture of the liver may be found with fatal intra peritoneal hæmorrhage, especially in premature infants, from awkward attempts at artificial respiration

All the injuries above mentioned are most frequently found in difficult forceps or in breech deliveries

Finally a look-out should be kept for developmental abnormalities which may have been incompatible with postnatal life, as absence of both kidneys, congenital diaphragmatic hernia, general fœtal dropsy, etc

Neo natal Death

By neo natal death is meant death occurring during the first month after birth   It may be due to injuries received during birth, *e g* cerebral or suprarenal hæmorrhage   The writer has known an infant live for sixteen days with large clots in both lateral ventricles   The commonest cause of neonatal death, however, is catarrhal pneumonia, which accounts for about 30 per cent of the total   Syphilis is one of the rarer causes of neo natal death   The infant is not infrequently premature, is usually marasmic if it has lived long enough, and may show other external signs of syphilis, such as a bullous eruption on the hands and feet   Internal examination may show the characteristic enlargement of the liver and spleen above referred to, but it cannot be too strongly emphasised *that a normal sized liver and spleen do not necessarily exclude syphilis*   In the lungs there may be interstitial pneumonia, but the latter may be present without showing any very marked evidences on naked-eye examination   In all cases where syphilis is suspected *great help will be obtained in diagnosis from histological examination of the organs,*

especially liver, lung, thyroid, and pancreas, as well as the placenta   The changes found are of a chronic inflammatory nature, and have been described elsewhere (see pp *239, 170, etc*)

Prematurity alone is sometimes the only cause of neo natal death found   At autopsy the lungs may be found more or less completely unexpanded, and are not infrequently the seat of catarrhal pneumonia—probably a contributory cause of death   In such cases it is important, *from the point of view of practical obstetrics, to find the cause of the premature labour*   Generally speaking an infant born before the thirty-sixth week of intra uterine life has a poor chance of survival, although its chances naturally vary with the surroundings and the care and attention that can be bestowed upon it

Points of Medico-legal Importance in the Examination of the Bodies of newly born Infants

In performing section upon newly born children the questions which require answering are —

1 Was the child viable ? *i e* was development sufficiently far advanced for the child to be able to live apart from the mother ?

2 Did the child actually live (*i e* breathe) either during or after birth ?

3 If the child lived, what was the cause of its death ?

In order to be able to answer these questions the points of chief importance to note are —

External Examination—Note the length of body, weight, the condition of the finger nails, the presence of the testicles in the scrotum, the presence or absence of a *caput succeda neum* (the presence of such indicating that the blood was circulating during birth) and head moulding

The condition of the umbilical cord, whether cut or torn, and whether any evidence of a *line of separation* having formed

TABLE SHOWING THE PRINCIPAL DEVELOPMENTAL CHANGES IN THE FŒTUS (Luff, SLIGHTLY MODIFIED).

Month	Length in inches.	Weight in Pounds.	Eyelids.	Pupillary Membrane.	Nails.	Testicles.	Centres of Ossification (as present.
6th	9-12	1-2	Adherent.	Present.	Just forming.	In abdominal cavity, immediately below kidney	Manubrium. Os calcis. Bodies and laminæ of sacral vertebræ.
7th	12-15	2-4	Non-adherent	Beginning to disappear	Finger nails not reached extremities of fingers	Near abdominal rings.	First piece of body of sternum. Astragalus
8th	15-18	4-5	Non-adherent	Disappeared	Reached extremities of fingers and nearly extremities of toes	In inguinal canals or upper part of scrotum, especially left testicle.	Second piece of body of sternum.
9th	18-20	5-8 Average 6½	Non-adherent	Disappeared.	Project beyond tips of fingers and reach end of toes.	In scrotum.	Lower epiphysys of femur. Third and fourth piece of sternum. Cuboid. First coccygeal vertebra.

The presence of *vernix caseosa,* blood and injuries to the skin

The neck should especially be observed for abrasions

The mouth and nostrils should be inspected for the presence of froth or any obstructing body

Internal Examination—Attention should be first con centrated upon the air passages and lungs in order to deter mine the question, *Has the child breathed ?*

The trachea should be opened and carefully examined for the presence of froth Some authorities recommend the tying of the trachea before opening the thorax This is not necessary

After opening the thorax, the contents of the thoracic cavity—lungs, heart and thymus gland—are removed and placed entire in a pail of water If the whole mass floats, there can be no further doubt about the question of the child having breathed Should the organs sink, then the individual lungs should be carefully examined as to the presence of any mottled areas that would indicate partial aeration The organs should then be cut up and the separate portions tested as to their capacity to float It may be advisable in some cases *to examine portions of the organs microscopically* (For the appearance of the non aerated lung, see Atelectasis, p 154)

Thereafter the examination proceeds in the usual manner, attention being, however, specially directed to *the presence of air in the stomach and small intestine* as conclusive evidence of breathing , also to the *presence of food in the stomach* as evidence of the child having survived its birth for some time

In all cases *the presence or absence of an ossific node at the lower end of the femur must be determined* in connection with the conclusion as to the stage of maturity attained (see table, p 391) For this purpose the cartilage of the epiphysis should be cut away in thin layers This should be done until

the diaphysis is reached in order to be quite certain as to the presence or absence of such a node. Another important centre of ossification for purposes of determining the stage of maturity reached by the child is that of the cuboid (see table, p 391)

The common causes of death in the new born child are as follows —

1 Compression of the umbilical cord

2 Protracted delivery

3 Malnutrition and immaturity

4 Hæmorrhage from the cord

5 Fracture, usually of bones of skull

6 Accidental asphyxia

7. Congenital malformation or disease

Among the modes by which death may be caused in cases of infanticide are the following —

1 Suffocation

2 Strangulation

3 Drowning

4 Fracture of skull

5 Exposure and neglect.

6 Hæmorrhage from the cord.

POST MORTEM CHANGES PRODUCED BY POISONS

As stated elsewhere (p 24), in cases of poisoning or sus pected poisoning, after examination of the lips and mouth, the tongue, together with the fauces, œsophagus, stomach, and duodenum, should be removed and examined *in continuity*

It should be carefully borne in mind that with certain exceptions the appearances in cases of poisoning are by no means characteristic There may be nothing at all in the alimentary tract to suggest poisoning Hence the necessity in all suspicious

cases for the preservation of the organs and stomach contents for subsequent chemical analysis

Appearances in Poisoning with Corrosives.—In all such cases there is *softening of the tissues of the upper alimentary tract*—lips, mouth, œsophagus and stomach   Sometimes there is *necrosis of the superficial layers of viscera*   The stomach shows *swelling and contraction of its walls, extravasation of blood, which under the influence of the acid becomes black, ulceration, and sometimes perforation*   The lining shows *in some cases a characteristic colouring, e g in the case of nitric acid a yellow colour*   The appearances in *sulphuric and hydrochloric acid poisoning are very similar* and cannot in many cases be differentiated   The only point of distinction is that *sulphuric is a stronger acid* than hydrochloric, hence the corrosion is more intense and there is a greater tendency to perforation ; the appearances varying, however, according to the dilution of the poison   The mucous membrane may be charred to a dark brown or black colour, or the appearances may be merely those of an intense gastritis   In poisoning with *carbolic,* if the acid has been taken in a concentrated form, there is *necrosis of the mucous membrane* particularly of the stomach with the formation of a *putty-like layer*   If the acid has been dilute, the interior of the stomach is dusky red from hyperæmia

In the case of *oxalic acid* there are as a rule no external appearances   When the acid has been taken *in the concentrated form* there is a *whitish appearance of the mucous membrane inside the mouth*   When dilute, the appearances are those of irritation, viz congestion

In poisoning with *caustic alkalies* the appearances are somewhat similar to those found in the case of acids, but the *tissues have a characteristic soapy feel*   In ammonia poisoning, in addition to the appearances of corrosion in the alimentary tract, there is generally *acute inflammation in the air-passages*

Appearances in Irritant Poisoning —*The common irritant poisons, such as arsenic, antimony, mercury, produce changes which do not differ to any extent from one another*   By the mere naked eye examination of the parts beyond the fact that the appearances may be those of acute gastritis and enteritis, *there is little that is characteristic*   In some instances, even when the poison has been taken in a concentrated form, there may be little to suggest that the case is one of poisoning As a rule, however, *the mucous membrane of the alimentary canal in its upper part is swollen and in parts hyperæmic*   In other words, the appearances are those of gastro-enteritis Occasionally there is ulceration

In the case of *phosphorus poisoning*, in addition to the evidence of irritation in the alimentary tract, there is *extreme fatty change in the liver* (which is of a bright yellow colour) also in the kidney and heart   Such cases have to be distinguished from acute yellow atrophy of the liver (see p 232), severe anæmias, and toxæmias   The distinction can, of course, be readily made on carrying out a chemical analysis of the organs

Appearances in Poisoning with Gases —In poisoning with *carbon dioxide* the appearances are merely those of suffocation The face, lips, and ears have a dark purple colour

The appearances in *carbon monoxide* (carbonic oxide) poisoning are as a rule typical   *Externally*, the post mortem lividity is of a pink or light red colour and the same colour can often be seen in the lips, conjunctivæ, and nails *Internally, while the blood in bulk may show no change yet wherever it is in a thin layer e g* the mesentery etc , *the pink or light red colour is most striking* The liver, spleen, kidneys and other organs frequently show the same change of colour

A simple but effective test can be carried out as follows — Take two test tubes partly filled with tap water , add to one

a few drops of normal blood and to the other a few drops of
blood from the body which is being examined. Normal blood
when diluted in this way will always give a *yellow* colour
Blood containing carbonic oxide, on the other hand, however
much it is diluted, will always be *pink*

A conclusive diagnosis can be made chemically as follows —
A small quantity of normal blood is placed in a test tube and
diluted with three or four times the amount of tap water   A
small quantity of blood from the case under investigation is
similarly treated   A small amount of tannic acid is dissolved
in three times its bulk of water   Add some of this solution to
both test tubes and shake.   In the case of the normal blood a
chocolate brown precipitate will form   Should the blood from
the case contain carbon monoxide the precipitate will be a
rose red

In poisoning with *ammonia gas* there is intense inflamma-
tion in the respiratory passages

In poisoning with *alkaloids*, such as *morphine, strychnine*,
etc., there is usually absolutely no abnormality visible
Occasionally tablets of the poison are found in the stomach.

In cyanide poisoning the characteristic odour may be
observed by those with a trained sense of smell   Similarly
in poisoning with chloral, sulphonal and chloroform

The appearances in cases of **vegetable poisoning** are in
no case very characteristic   Search should be made in the
intestinal tract for the presence of seeds, leaves, or other
evidence of vegetable tissue

In cases of meat poisoning, cultures should be made from
the intestinal contents and from the spleen   Blood should
be removed in order to test the serum against various micro-
organisms for the presence of specific agglutinins (see p 457)

SPECIMEN POST MORTEM REPORTS

The following are typical post mortem reports in the form in which they should be sent to the Procurator Fiscal —

A

EDINBURGH, 4th June 1909

WE hereby *certify on soul and conscience, that by* instructions of the Procurator Fiscal of the County of Midlothian, on

SATURDAY, *3rd June* 1909,

in the Mortuary of Edinburgh Castle, we examined the body of a man which was identified in our presence by

Sergeant JOHN SMITH,

and by one of us,

Captain JONES, R A M C.,

as that of

Private JAMES SCOTT

The body was that of a well built muscular man, 70¾ inches in height, and apparently about thirty five years of age. The body showed no signs of putrefaction, and the usual post mortem rigidity and lividity were present.

Situated on the right side of the chest, and in a line drawn between the junction of the collar bone and breast bone above and the right nipple below, there was a linear wound one and a half inches in length, the edges of which had been brought together by means of three stitches. The upper extremity of this wound was distant one and a half inches and the lower end two and a quarter inches from the middle line of the body. This wound was found, in the first instance by means of a blunt probe, and subsequently, during the course of the dissection *to proceed obliquely through the second intercostal space* downwards, backwards, and towards the left side, and to pass through the upper lobe of the right lung near its anterior

margin, into the pericardium, and finally to enter the right auricle of the heart above the auricular appendage and close to the junction of the superior vena cava with the auricle. *The length of the wounds in the lung and pericardium was one inch, and that in the auricle half an inch*

With the exception of the injury above described, the body presented no marks of external violence

The right pleural cavity was full of coagulated blood. The right lung was collapsed and bloodless. The left lung was healthy. The heart contained some coagulated blood, and with the exception of the wound in the right auricle, was normal

The liver, spleen, kidneys, and other abdominal organs presented normal appearances

The stomach contained a quantity of green bilious fluid Its mucous membrane was in the condition of chronic catarrh

The mouth, upper air passages, and trachea were healthy

The brain and its membranes were congested, but otherwise they were normal.

From the foregoing examination we are of opinion that death was due to loss of blood from a wound of the heart produced by a sharp, pointed instrument.

<div style="text-align:right">Signed by the two medical men
present at the post mortem</div>

B

We hereby certify upon soul and conscience, that we yesterday,

<div style="text-align:center">THURSDAY, 20th *May* 1897,</div>

examined, in the Royal Infirmary, the body of a man, which was identified in our presence by

the Wife of the deceased,
by a Police Constable, and by the
House Surgeon attending the case,

as that of

THOMAS ROBINSON.

Deceased was an able bodied person, apparently about sixty years of age. The only mark of violence observable was a lacerated wound of the nose, situated on the prominence, and about a quarter of an inch in length Its edges were somewhat swollen and gaping It was partially covered with a soft scab. The root of the nose was also somewhat swollen

The various cavities and their contents were carefully examined , but with the exception of marked congestion of the spinal cord, and the effects of the wear and tear of life, nothing unusual was detected.

Portions of the heart, liver, and kidneys were subjected to examination by the microscope   They were all more or less fatty, but not to a great extent

We are of opinion that the cause of death in this case was acute congestion of the spinal cord, such as we are conversant with in fatal cases of Tetanus

Signed by the two medical men
present at the post mortem.

APPENDIX A

TREATMENT OF SPECIMENS FOR MOUNTING

Fixatives —In many cases the pathologist will meet with specimens which he wishes to preserve for purposes of further examination, reference, or teaching It is his object to keep, as far as possible, the form of the organ or part and its natural colour For this purpose the tissue must be fixed. The best all round fixative is certainly formalin, but by itself it does not penetrate well, and the colour is not well preserved. Salts of various kinds should be mixed with it. The resulting fluids are variously known as Pick's, Jores's, and Kaiserling's solutions. The formulæ for making up these are given on pp 404 5 Of the three, probably Pick's solution costs least to prepare There is, however, little to choose between them as regards results. The explanation underlying the preservation of the colour of the organ in the case of all three is as follows the oxyhæmoglobin is transformed by the formalin into acid hæmatin which has a brown colour ; this, under the influence of the alcohol, becomes alkaline hæmatin, which has a bright red colour so like the original oxyhæmoglobin that the natural colour appears to have been returned

Method of preparing Specimens —The specimen is placed in this fluid after having been cut open, or after having the fluid injected into it, the object being to secure the penetration of the fluid to the organ or part by the fluid so as to prevent subsequent shrinkage or deformity Specimens are treated differently according to their nature and consistence It should always be remembered that a large excess of fluid is necessary for proper fixation.

Solid Organs—There are two ways of dealing with solid organs, such as liver and spleen, if it is desired to preserve the organ whole. Fixative must either be injected into the main vessel—in the case of the liver, the portal vein—or the fluid is injected here and there into the substance of the organ with a syringe

In most cases it is not necessary to preserve the whole organ, in which case the best way is to cut it into a series of parallel slices about an inch thick. In the case of the kidney it is sufficient to open up the organ in the usual way. The brain is best injected through the large arteries at the base. In the case of superficial exudates in the meninges or else where some stronger formalin may be smeared over the surface so as at once to fix the material. When dealing with large tumours, it is well to inject fluid with a syringe here and there, more especially in the softer parts

Groups of Organs—When dealing with a group of organs, it may be necessary to fix them prior to removal. This can be done by injecting fixative into the circulation through one of the carotids or into a main vessel going to the part.

Lungs—In the case of the lungs, it is best to inject the fluid into the bronchi, and, in addition, into any cavity or area of softening, before opening up the organs. If they have already been opened, it is usually sufficient to immerse each half in fixative.

Cysts—When dealing with cysts, such as hydronephrosis, pyonephrosis, hydatid cysts, etc., the greater part of the fluid in the cyst should be removed with a syringe and replaced by fixative.

Intestine—Portions of the intestine should either be opened up, washed, laid flat or pinned out flat, and immersed in fixative, or they may be washed out by running water through them, then, having tied one end, fixative is poured in at the upper end, the upper end tied, and the whole immersed in fluid. This latter method is more especially adapted to the preservation of tumours, the bowel being subsequently slit up into two halves, as has been done in the case of Fig 69

Time necessary for Fixation—As regards the time during which specimens should remain in the fixative, this depends upon their size and consistence. Thin tissues, such as

intestines treated as above, are fixed in twenty four hours
Lungs injected through the bronchi, and brains injected
through their vessels, will be fixed sufficiently for cutting in
forty-eight hours   It is necessary, however, to leave the
slices some time longer in the fixative. For more solid organs,
such as liver, kidney, spleen, or heart, ten days to three weeks
will usually suffice, but the specimens take no harm from
remaining considerably longer   A good test as to whether
or no an organ is fixed is to squeeze it   If red blood exude
it is well to leave the specimen some time longer   Another
test is, of course, the consistence of the organ   As a rule, so
long as it is soft, further fixation is required

Mounting Fluid —When properly fixed, the organ is
washed in clean water for some minutes and placed over
night in methylated spirit, which may have been previously
used   It is then placed in fresh, clean spirit, until the colour
has returned, a few hours is usually sufficient   The specimen
is then washed again in running water for a few minutes, and
placed in the following fluid —

| Glycerine (pure) | . | 1 part |
| Water | . | 2 parts |

To each Winchester quart of the above, 1 fluid oz. of formalin
(40 per cent) is added, also 1 oz of a saturated solution of pure
potassium acetate.   The object of the formalin is to prevent
the growth of mould.   This fluid should be changed once or
twice, and when the specimen is finally mounted in a glass
jar, the same fluid should be filtered in   In such a fluid a
specimen will remain soft and retain its natural colour for
many years   Care should, however, be taken not to expose
the specimen to direct sunlight, otherwise fading of the colour
will occur

Mounting —When selecting a jar for permanent mounting,
the nature and size of the specimen will, of course, be taken
into consideration   As a rule, the rectangular glass jars are
the best, the specimen being fixed to one side of the jar by
means of a little gelatine, or secured to a plate of glass
with strong thread.   Whole hearts and spleens are best sus-
pended in round jars   Portions of intestine had open can

be stretched upon sheets of glass or mica, or within a frame formed of a bent glass rod. The interior of cavities and the surfaces of organs are best coated with gelatine fluid, which is prepared as follows, in order to prevent portions coming away and producing turbidity :—

> 100 grains pure gelatine
> 800 c.c. thymol water (saturated in the cold)
> 200 c.c. glycerine

This is gently heated until the gelatine melts A few drops of acetic acid are added, and the whole is clarified with white of egg The gelatine is poured upon the specimen while warm and fluid and allowed to solidify before the specimen is mounted For fixing on the cover of the jar the best medium is a mixture of litharge and Archangel tar in quantities sufficient to make a thick paste. A band of Berlin black should then be painted round the margin of the cover

Summary of Steps in Treatment of Specimens for Mounting

1. Place in Pick's, Jores's, or Kaiserling's fixative (for composition see below) for a variable period depending upon size, consistence, etc., of specimen

2. Wash in clean water for some minutes.

3 Place overnight in methylated spirit which has been previously used.

4 Transfer to fresh spirit for a few hours until colour returns

5. Wash in running water for a few minutes.

6 Place in glycerine and water (one part of the former to two of the latter), to which potassium acetate (1 ounce sat sol. to Winchester quart) is added, also formalin to prevent the growth of moulds

7. Mount in fresh fluid of similar composition.

Pick's Fixative

Formalin (pure, *i e* 40 per cent)	.	50 c.c.
Artificial Carlsbad salt	.	50 grm.
Distilled water	.	1 litre

The Carlsbad salt is prepared by mixing Sod sulphate 22 parts, Sod. bicarb 18 parts, Sod chloride 9 parts, Pot sulphate 1 part. The last ingredient is not essential.

Kaiserling's Fixative

Formalin	.	.	.	.	.	100-200 c.c.
Pot nitrate	.	.	.	.		15 grm
Pot. acetate	.	.	.		.	30 grm.
Water	.	.			.	1 litre.

Jores's Fixative

Formalin	.	.	.	.	.	50-100 c.c.
Mag sulph.	.	.	.	.	.	20 grm.
Sod sulph	.	.	.	.	.	20 grm
Sod. chloride	.	.	.	.	.	10 grm
Water	.	.	.	.	.	1 litre.

In each case to obtain the best results the formalin used should be Schering's It costs about twice the price of the ordinary commercial formalin, but it is greatly superior in quality

The salts for the various fixatives may be made up in packets and mixed with the water and formalin as required.

In the case of each of the methods, after fixation is complete the specimen is transferred to methylated spirit in which the acid hæmatin becomes alkaline and the colour thus returns to the blood in the tissue

After twenty four hours the specimen is placed in a preservative which in each instance contains glycerine as its principal ingredient As a rule the glycerine is diluted with double the quantity of water to which potassium acetate (in the case of Pick's and Kaiserling's method) is added.

Mr. R. Frost of Sheffield (Proc. Path Soc Great Britain and Ireland, Jan. 1912) has proposed the following as a preserving medium —

Sod fluoride	.	.	.	.	80 grm
Chloral hydrate	.	.	.	.	80 grm
Pot. acetate	.	.	.	.	160 grm.
Cane sugar (Tate's cube)	.	.	.	3500 grm.
Thymol water (saturated)	.	.	.	8 litres.

The chief advantage of this medium is its cheapness

TREATMENT OF TISSUES FOR MICROSCOPIC PURPOSES

Necessity for Routine Microscopic Examinations

For a complete investigation of a fatal case of disease, it is necessary not only to examine as many parts of the body as possible with the unaided eye, but to investigate them further by means of the microscope. This routine examination of the organs microscopically cannot be too strongly insisted upon. Where only specimens of exceptional interest are put through and cut, the pathologist will never be able to acquire skill in differentiating the finer shades of pathological change. Further, diseased tissues do not always bear their secrets stamped upon them plainly, and unless a microscopic examination is carried out as a matter of routine, much that is of exceptional interest will be lost.

Selection of Portions of Organs or Tissues

As regards selection of a portion of a diseased organ, no definite rules can be laid down. It is well not to be satisfied with a single portion, but to take several pieces from different parts. Where one is dealing with a tumour, one section should include the capsule or a portion of any invaded tissue. If the tumour be in the bowel, along with the portion should be taken a piece of the normal gut wall. In the case of such organs as kidney, liver, and spleen, one section at any rate should include the capsule. Sections of the kidney should of course include both cortex and medulla.

It is not at all a bad plan to cut the different organs in different ways, or at any rate to pare them down to different shapes after they have been passed into spirit. Thus, kidney may be cut as a triangle, the base being the capsule, liver cut in squares, and spleen in the form of a rectangle. The advantage of this method is that afterwards, when the tissues are being passed through the various reagents and also when in paraffin, they may be recognised at a glance.

In any case, the section of the organ should be thin. It

cannot well be too thin   A good average thickness, except for certain purposes, is $\frac{3}{4}$ inch.   In the case of tissue which is to be fixed in such mixtures as Flemming's or Marchi's still thinner sections are required   This does not mean that the pieces of tissue must not be large   As a matter of fact, it is most advantageous to have large sections, although they are much more difficult to cut with the microtome   In the case of lung preparations, it may be safely said that the sections cannot be too large   It is exceedingly difficult, if not im possible, to judge of the nature and distribution of pulmonary diseases from a minute portion of lung taken out at random.

These statements do not apply to sections for all purposes When examining minute changes by serial sections, it is well to have small pieces for cutting, because it is obviously much more easy to find corresponding areas in the sections above and below any given point if the portion of tissue is minute.

When dealing with portions of the bowel, it is well to pin out a fairly large area of intestine upon a small block of wood and immerse both in the fixative   Subsequently, smaller portions may be cut or snipped out.   For any of the above purposes a sharp scalpel or razor is required.   In certain cases it may be advisable to fix the specimen entire before cutting away any portion for microscopic examination.   This par ticularly applies to tumours of the stomach and bowel   In any case, *it never spoils a specimen neatly to cut out a small piece* for microscopic purposes

It is well at the same time as one takes the sections to make a note of any matter of importance upon the label of the bottle in which the tissues are to be placed, such as the part of the organ from which the specimen was taken   Instead of *pasting it on the bottle, the label written in pencil may be* placed inside the bottle along with the specimens

Fixation of Tissue

It is impossible to cut in the fresh condition sections of organs thin enough for microscopic purposes   Parenchy matous cells and softer parts fall out, leaving a mere skeleton of fibrous tissue   It is necessary therefore, in the

first place, to fix the tissue. There are many fixatives for tissues, but for ordinary purposes 10 per cent formalin (*i e* 10 per cent of the commercial 40 per cent formaldehyde) is probably the best. It is readily procured and made up, penetrates well, and gives excellent results For this purpose undoubtedly Schering's formalin is the best With other brands, costing less, precipitates are very apt to form, especially in tissues containing much blood For certain purposes other fixatives may be employed and as a matter of fact, when dealing with cases of special interest, it is well to use more than one fixative One of the advantages of formalin is that other methods of fixation can be employed subsequently, such as bichromate of potash and osmic acid, another is that sections can be placed in gum, frozen, and cut directly from the formalin solution. As in all methods of fixation, it is essential to have plenty of fluid—at least twenty volumes of fluid to one of tissue.

Treatment of Tissue for cutting in Gum

Suitable portions of tissue are placed in the 10 per cent formalin, and are left for twenty four hours In the case of thick pieces, it is well to leave them longer At the end of that time, if a rapid diagnosis is required or if it is necessary to stain for the presence of fat, pieces of the organs can be transferred directly from the formalin to a gum solution made up as follows —

Gum Arabic	1 part,
Water	3 parts,
Thymol a few crystals,	

and subsequently frozen and cut.

Although good results are obtained by cutting directly after fixation in formalin it is better to harden in spirit for 24 hours or longer, to wash out the spirit in running water overnight, and subsequently to place in gum solution for some hours.

Other Methods of Fixation

1 For the brain, cord, or other portion of the nervous system, where it is desired to preserve the myelin sheath of

the nerve elements, it is necessary to fix the myelin substance by bichromate of potassium or other similar salt For this purpose, *Muller's fluid* is as good as many others of more recent introduction It is made up as follows —

Bichromate of potassium			2 5 grm.
Sulphate of sodium			1 grm.
Water			100 c.c.

The sodium sulphate of the Muller's fluid may, according to Mann, be omitted without the solution suffering as a fixative

Portions of brain or cord may be placed in this direct or, better, transferred to it from formalin They should be left in the fluid for six to eight weeks, washed thoroughly in running water for some hours, and transferred first to 50 per cent spirit, then 75 per cent, lastly pure spirit The bichromate fluid should be *changed frequently* during the process of fixation The process can be hastened considerably by placing the fixative containing the pieces of cord in the incubator at 37° C

Although tedious, the above method gives very good results, even with specimens which have to be stained with ordinary methods Muller's fluid also forms the basis of a number of other fixation methods, so that it is advisable to keep it in considerable quantity in stock

2 *Zenker's Fluid.*—This can be made from Muller's fluid by adding corrosive sublimate, 5 grams, and glacial acetic acid, 5 c.c. to every 100 c.c It is advisable to add the acetic acid as required to the quantity of stock solution used, as it readily *evaporates if kept* The tissues should be fixed in the above for twelve to twenty four hours At the end of that time wash in running water for some hours and place in methylated spirit till required

This is an exceedingly good method of fixation for most purposes The solution penetrates well and preserves nuclear structure admirably One objection which it has in common with all mercury fixatives is that the mercury becomes precipitated in the tissues This can be removed by means of iodine, which forms with it a colourless soluble compound *The iodine may be added to the spirit in which the tissues are*

preserved, or, what is a better way, the sections may be treated with Lugol's fluid (see p. 432) or a 1 per cent alcoholic solution of iodine for ten to twenty minutes before staining, followed by treatment with spirit to remove the iodine

Orth's Fluid —This is simply Muller's fluid in which 10 c c pure commercial formalin is added to the 100 c.c. The formaldehyde should be added immediately before the fixative is used. Fixation is complete in three to four days The specimens are afterwards washed in running water, and placed in methylated spirit Mallory states that the addition of 5 per cent acetic acid improves the fluid The fluid is an excellent fixative for most purposes.

4. *Marchi's Fluid*.—This is Muller's fluid two parts, to osmic acid (1 per cent aqueous solution) one part. As in the case of all osmic acid fixatives the sections should be very thin They should remain in the fluid three days protected from light. They are afterwards washed in running water and hardened in spirit. The method is specially applicable to the demonstration of recent areas and tracts of degeneration in the spinal cord and brain (see p 438).

5 *Flemming's solution* is made up as follows —

Osmic acid 2 per cent aqueous solution	.	4 parts
Chromic acid 1 per cent „ „	15 „
Glacial acetic acid	.	1 part.

The portions of tissue should be exceedingly thin, as the osmic acid penetrates badly They are left in the fluid for one to three days in the dark, subsequently washed in water, and hardened in spirit. The method is specially applicable to the study of nuclear changes, and to the demonstration of olein fats

6 *Corrosive sublimate*, a saturated solution in normal saline with, if desired, the addition of 5 per cent glacial acetic acid. The tissues are fixed for twelve to twenty-four hours, washed thoroughly in water and hardened in spirit More especially is it applicable to the fixation of tissues when it is desired to demonstrate granules in the leucocytes and other cells. The same objection as in the case of Zenker's fluid holds good with corrosive sublimate. The sections must be treated with iod ne before staining in order to dissolve the mercury

7 *Absolute alcohol* and *methylated spirit* are both fixa
tives as well as hardening agents   Under their influence,
however, the tissues and cell elements tend to shrink consider
ably   They are said to be specially good for tissues in which
it is desired to demonstrate bacteria   But as a matter of fact
formalin and corrosive sublimate are equally as good.

It is always desirable to plug a little cotton wool in the
bottle in which the fixation is carried out, in order to prevent
sections adhering to the bottom   It is also desirable, parti
cularly when dealing with unconsolidated lung, to place some
at the top, in order to prevent the pieces of tissue from float
ing   Remember always to have a large excess of fluid
present

Sending Material to a Distance

The practitioner not infrequently desires to send pathological
material to some institute or hospital where expert opinion can
be obtained.   For this purpose the best fluid in which to place
the tissue is 10 per cent formalin   The pieces of tissue should
be small, and at least ten times as much fluid as tissue should
be present in the bottle, otherwise penetration of the fixative
will be incomplete and putrefactive processes will progress
In the absence of formalin, methylated spirit or absolute
alcohol may be used

Treatment after Fixation

After fixation is complete, as a rule it is advisable to wash
the tissue in running water   This is absolutely necessary when
fixatives, such as Zenker's, Orth's fluid, corrosive sublimate,
Flemming's, have been used   It is not necessary in the case
of formalin fixed tissue   The latter may be placed directly in
methylated spirit

Hardening —After fixation, or if necessary after fixation and
washing, the tissue is placed in methylated spirit.   This can
be done by placing directly in commercial methylated spirit or
by passing through dilutions (50 per cent and 70 per cent)
first.   For ordinary purposes the dilutions may be omitted,
especially when one is dealing with material removed from
the body twenty four or forty eight hours after death.   When

it is desired to preserve the finer details, more especially when one is dealing with the central nervous system, then passage through the dilutions is advisable, as there will probably be somewhat less shrinkage in the cell elements   In addition to hardening the specimen, the passage through spirit also to a certain extent dehydrates

Dehydration.—The next process is dehydration, or the removal of all water from the tissue   Some tissues are more difficult to dehydrate than others   As a rule the denser the tissue the more difficult it is to dehydrate   For this reason any specimen containing well formed connective tissue requires longer than a specimen such as, for example, normal liver   For purposes of dehydration it is well to use two changes of absolute alcohol.   As a rule, a few hours in the first alcohol and twenty four hours in the second is sufficient.   The alcohol must be replaced by fresh after being used for a succession of specimens during a few days.

Embedding

The further treatment of the specimen depends upon whether one wishes to cut the sections in paraffin or celloidin   In the case of most organs and tissues, it is necessary to impregnate with some substance which will hold together the cellular elements during the process of cutting and staining   For this purpose, paraffin or celloidin is commonly employed.   Each has its own special advantages, each therefore has its supporters.   Probably paraffin is more generally used, so we shall consider it first.

Embedding in Paraffin.—From the absolute alcohol, the sections are placed in a clearing fluid, which may be chloroform, benzol, xylol or some such chemical substance, benzol being the cheapest of those mentioned   All these have this in common that they readily mix with alcohol on the one hand, and with paraffin on the other   At least twenty four hours should be allowed for this clearing process, and it is well to use two changes of the clearing medium.

The sections should then be transferred to benzol, or what ever clearing agent is employed, to which some pieces of paraffin have been previously added, and the bottle placed on

the top of the paraffin oven, or inside the incubator At this
temperature, which will be about 37° 40° C, benzol will, of
course, take up much more paraffin   From this mixture, at the
end of twenty four hours, the pieces of tissue are placed in a
shallow uncovered dish containing pure paraffin, in the interior
of the paraffin oven   Here they remain until all the benzol
has been driven off   If the sections are not too thick or if
they are turned over at intervals, a few hours will suffice   It
is important on the one hand not to leave the specimens too
long, because the heat of the oven shrivels them   On the
other hand, it is necessary to drive off all the benzol, else the
tissue will shrivel afterwards and will not cut well   As a rule,
if they are placed in the pure paraffin (melting point 50° 53° C)
the first thing in the morning, they may be cast the same day,
some time during the afternoon.   The criterion for the whole
of the benzol having been driven off is the absence of the char
acteristic odour on shaking the dish containing the pieces of
tissue.

To cast the specimens, two L-shaped moulds are placed
upon a porcelain slab, so as to shut in a space the size of
which will vary with the number and size of the specimens
Melted paraffin from a large dish is then poured in to the
depth of about 1 centimetre, the specimens are transferred by
means of a warm pair of forceps, and placed, according to the
direction in which it is desired to cut them, in the fluid paraffin
upon the porcelain slab   When the surface of the paraffin has
solidified, slab, paraffin and moulds may be placed in cold
water and the blocks removed when solidification is complete

The above periods for dehydration, clearing, etc., may be
considerably shortened if the specimens be small and thin
Various abridged methods are in use, of which the following is
a reliable one   At the same time, it must be remembered that
leisurely methods give the best results

Quick Method for embedding in Paraffin (Mallory and
Wright) —Small pieces of tissue or organ are placed in two
changes of acetone for half to two hours   The acetone must
be in large excess   From this they are transferred to xylol
or chloroform for fifteen to thirty minutes.   They are then
placed in pure melted paraffin for half an hour to an hour and
a half at 57° C   Embed in paraffin

Summary of Method of embedding in Paraffin

Fixation in formalin for	.	24	hours.
Hardening in spirit for at least		24	,,
Absolute alcohol, two changes		24 48	,,
Benzol, xylol, or chloroform, two changes		24	,,
Benzol, etc, saturated with paraffin at 37° C.		24	,,
Pure paraffin, melting point 50° 53° C		6 12	,,

Cutting Preparations embedded in Paraffin.—For cutting sections embedded in paraffin, one of the improved rocking microtomes made by the Cambridge Scientific Instrument Company is probably the best   No special knife is required. Suitable razors are supplied by Hilliard, Edinburgh, for 3s. They must be kept in good order by frequent stropping and occasional setting on a Canadian hone   The block of paraffin, in which the specimen has been cast, is pared down to a con venient size with a penknife   It is fixed to one of the dies, which screws on to the arm of the microtome, by means of a heated piece of metal—the end of a copper section lifter will do admirably   The screw regulating the thickness of the section is adjusted to the desired position (about 10 microns), and a number of sections are cut. These can be lifted by means of a fine-pointed pair of forceps and a small brush, and placed in warm water about 44° C.   When the sections have flattened out they are mounted singly, or, if desired, in a series, on a clean slide. Slides previously smeared with albumin (egg albumin in water) have this advantage, that the sections adhere to them more firmly   The slide, or series of slides is then placed in a slanting position till dry   They are then placed on the top, or, in the paraffin bath, or in an incubator at 37° C.

Embedding in Celloidin.—The sections are taken from absolute alcohol and placed for twenty four hours in a mixture of equal parts of absolute alcohol and ether   From this they are transferred to a dilute solution (2 per cent) of celloidin (Schering's granular) in equal parts of alcohol and ether

They may be left in this for twenty four hours or longer, and at the end of that time are transferred to a 6 per cent solution of the same material.   Here they remain for twenty four hours more

To cast the specimens, take a cube of wood of a suitable size.   Pour a little celloidin over the cross grained surface, then place the specimen on it and pour a little more over Allow the whole to dry till it is of a firm consistence, then place in 85 per cent methylated spirit.

The celloidin method of embedding is more especially used *for sections of the brain, spinal cord, bone, and skin, but it is ap-plicable to all types of tissue*   Its chief advantage is, that during the process of impregnating the specimen with the celloidin no heat is applied.   Another advantage which it has over the paraffin method is that the sections are floated in the staining fluids and not fixed to slide or cover glass   This allows of the stain acting from two surfaces, and undoubtedly has the result of giving a more natural appearance to the tissue elements

Cutting Preparations embedded in Celloidin.—For cutting such preparations a number of microtomes are avail able   Among them the Schanze, Minot, and, for large sections, the Bruce microtome are the best known   Special knives are always supplied with these, which require great care in order *to keep sharp*

While cutting, the specimen and the knife are always kept moist with 80 per cent spirit, applied one or two drops at a time by means of a large brush   Serial sections may be obtained by placing the sections as they are cut upon tissue paper moistened with spirit   The sections are lifted with a brush, and placed in 80 per cent spirit until they must be stained   From this they are taken and either washed first or placed directly in the staining fluid

Cutting Sections in Gum—As previously stated, it is advisable to fix specimens before cutting them.   It is possible, however, to obtain sections good enough for making a diagnosis, as, for instance, *at an operation while the surgeon is waiting*, by placing a small piece of tissue in gum and immediately cutting it.   When such rapidity is not demanded, twenty four hours' fixation in 10 per cent formalin is sufficient, but where time permits, and when it is not desired subsequently

to stain for fat, it is well in addition to harden the tissue in spirit for a day or two This should not, of course, be done with sections which are subsequently to be stained for fat. At the end of that time the spirit should be washed out in running water over night, and the specimen placed in gum for some hours It is absolutely necessary to wash out the spirit thoroughly *and to allow sufficient time for the gum to penetrate.* Sections cut in this way give as good results as any when suitably stained For many tissues, notably lung, the results are as good as those obtained with the best celloidin sections, and the tissues are less subjected to the influence of chemicals, *and in consequence are less shrunken.* Further, very large sections can be obtained by freezing, the size only being limited by the size of the freezing stage, and this, as has been already emphasised, is a matter of supreme import ance in studying lung disease. Formerly, when ice and salt had to be used for freezing, the method was clumsy Later, the introduction of ether simplified the process , but in these days of liquid CO_2 no method of cutting sections is more simple or effective

With regard to the type of microtome, the Cathcart, with ether freezing, is a useful little instrument, particularly for travelling purposes, when the pathologist accompanies the surgeon to an operation

For laboratory purposes undoubtedly one of the numerous CO_2 freezers is preferable, owing to its more rapid and more powerful action Of the more elaborate CO_2 microtomes, the Aschoff Becker is very good A simple one is that introduced by Dr Mixter, and used largely in America.

The piece of tissue is placed upon the stage of the microtome, and some gum poured on the top and round it The carbonic acid gas is then turned on and off a number of times till the specimen is opaque, white, and hard. In this condition the knife will not cut it, but when it is just com mencing to thaw the best sections will be obtained. To prevent the deeper portions from thawing, the gas should be turned on every now and then A razor, the blade of a carpenter's smoothing plane, or one of the special knives supplied with the microtomes is used for cutting The sections are removed with a brush and placed in a basin of

cold water, where they will gradually flatten out. The sections may be stained at once, or preserved in formalin water, or better, in spirit, for future use. When it is desired to stain fat, spirit cannot of course be used.

Decalcification

Tissues which contain bone or calcium salts, such as atheromatous patches in the aorta, calcareous tuberculous glands, etc, require to be decalcified before being cut, otherwise the razor or knife employed will be ruined Before decalcifying, the portion of bone or tissue is fixed, having been previously sawn or cut to the desired size. As fixative, formalin 10 per cent, Zenker's or Orth's fluid may be used After decalcifying, the specimen is placed in methylated spirit for at least twenty four hours

There are many decalcifying fluids, the chief constituent being, in all cases, *some acid* In order to ensure the penetration of the acid, the fluid should be frequently changed, and should be used in large quantity Unfortunately, nuclei are always damaged by such acids, so that the sections require to be stained for longer periods and never give quite such good results as tissues which are not so treated.

Nitric acid is one of the most effective decalcifying agents It is used in a 5 per cent aqueous solution For rapidity of action Perenny's solution can be strongly recommended It is made up as follows —

Nitric acid, 10 per cent	.	.	.	400 c.c.
Absolute alcohol	.	.	.	300 c.c.
Chromic acid, $\frac{1}{2}$ per cent	.	.	.	300 c.c.

In the above solution decalcification is usually complete, if moderately thin pieces of tissue are used, in from ten to fourteen days

Apparatus required in Staining

As regards apparatus required, this depends upon the way in which the sections have been cut. Slides 3 in × 1 in for ordinary sections, and 3 in × 1½ in for larger sections, as well as cover

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glasses (No 1 and No 2) will always be required. For sections cut frozen or in celloidin, a series of watch glasses to hold the staining fluids and reagents, a bowl of water for washing between the processes, needles for lifting the sections, drop-bottles containing absolute alcohol and xylol, and a bottle of Canada balsam, also glycerine jelly or Farrant's medium, are all that is required. In the case of sections cut in paraffin, these may have been mounted either upon cover glasses or on slides. In the former case, a series of drop-bottles containing the reagents and a pair of Cornet's forceps to hold the specimen are all that is necessary. In the latter case it is well to have a series of stoppered jars, of a size suitable for holding at least two slides, back to back, for stains and reagents. A tap for cold water and a sink should be at hand, also a jar containing distilled water. A pair of scales for weighing out stains is also necessary.

For sections cut in celloidin, watch glasses or other small glass dishes for the stains and reagents, and needles for lifting the sections, are required.

Slides and cover glasses should always be clean; more especially they should be free from grease. The best way of securing this is to place them in strong hydrochloric acid for a short time, then wash in running water, and finally put them into a jar with a properly fitting top containing methylated spirit. From this spirit they are taken and dried with a *clean* cloth as they are required.

Mounting Media

Canada Balsam.—This is prepared by dissolving the balsam either in benzol or xylol. The solvent is added in sufficient quantity to give a yellow fluid with a syrupy consistence. The balsam should be kept in one of the specially prepared stoppered bottles. It is necessary to add a little of the solvent from time to time to replace that which evaporates.

In the case of tissues treated with osmic acid, chloroform should take the place of the benzol or xylol.

Sections which have been stained in anilin dyes such as thionin tend to become discoloured when mounted in ordinary balsam. This is due to the fact that ordinary balsam is acid

as a result of oxidation. In neutral balsam, which may be obtained from Grubler, Leipzig, the colour is preserved for a much longer period. Another way of getting over tne difficulty is to mount the section in *Colophonium* dissolved in terpentine oil.

Glycerine Jelly —This is specially useful in mounting sections which have been stained for fat or waxy material. It contains—

Gelatine (Coignet's)	30 parts.
Distilled water	70 ,,
Glycerine	100 ,,
Alcoholic solution of camphor	5 ,,

After standing overnight in the distilled water the gelatine and water are boiled and subsequently strained through a warm filter   The glycerine and camphor are added and mixed thoroughly   Before use the medium should be liquefied by being placed in warm water

Farrant s Medium —Equal parts of water glycerine and a saturated watery solution of arsenious acid (saturated by boiling) are mixed together thoroughly   To this is added about half its bulk of gum arabic   The mixture is stirred from time to time until solution is complete   It is then filtered and a little carbolic (1 20) added

STAINING METHODS

Treatment of Sections cut in Paraffin before Staining —Before staining, sections which have been cut in paraffin require to be treated with some solvent for paraffin   such as benzol or xylol   The reagent is dropped on to the section and the slide or cover glass gently tilted backwards and forwards for some seconds   The benzol is then poured off and replaced by fresh   The process of solution of the paraffin may be hastened by warming the slide or cover glass *very gently* well above the flame of a bunsen until the paraffin is seen to melt   The benzol is then poured on and allowed to remain for a few seconds

The benzol must now be washed off by means of a few drops of methylated spirit, the slide being inclined so as to

allow the fluid to run away. The section is now gently immersed in water and left for a few minutes before staining. The stain is then dropped or filtered on to the section, or the section and slide are placed in a suitable jar containing the stain.

Treatment of Sections cut in Celloidin and Gum—Sections cut in gum or in celloidin are taken direct from water by means of a needle and placed in the staining fluid, usually in a watch glass or similar hollow dish. Such sections stain much more rapidly than those cut in paraffin, by reason of the fact that the stain acting upon the tissue from both sides penetrates more readily.

Picro-Carmine

This is a combined nuclear and protoplasmic stain. It also has the advantage of differentiating between various types of tissues and cells. The nuclei of cells and fibrous tissue are stained brilliant crimson. Epithelial cells, necrotic material, fibrin and elastic tissue are stained yellow. The stain is prepared as follows —

Pure carmine	.	1 part
Liq ammoniae fort.	.	3 parts
Dist water	.	3 ,,

Dissolve the stain in a test tube in the ammonia and water and add 200 parts of a cold, saturated, and filtered solution of picric acid, and mix thoroughly. Place the fluid in a basin covered with glass and allow to ripen in direct sunlight, testing its powers of staining from time to time. To prevent the picric acid crystallising out, add 10 to 20 per cent of distilled water to the fluid that remains. Add also 2 to 6 drops of 1 to 20 carbolic to prevent the growth of fungi.

Method

Spread the section out on a cover glass, drain off superfluous water. Run several drops of staining fluid over and allow to stand for fifteen to twenty minutes. Drain off excess of stain. Do not wash. Mount in Farrant's medium.

The method is specially useful for sections cut in gum.

Hæmatoxylin (Hæmatein), Eosin

Hæmatoxylin is obtained from the wood of *Hæmatoxylon campechianum* by extraction with ether   It is not in itself a dye but becomes one on oxidation   In its oxidised form it is known as hæmatein   Neither the original substance nor the oxidation product is capable of staining directly   Each requires a mordant added to it or used separately   As mordants, alum and iron are very commonly used

There are many useful methods for staining with hæma toxylin and hæmatein   They all give very similar results, the nuclei staining a dark blue or purple colour

Of the hæmatoxylin methods probably the best, both as regards ease of preparation of the stain and rapidity of action, is Weigert's iron hæmatoxylin

Weigert's Iron Hæmatoxylin —Two solutions are prepared, No 1 containing the hæmatoxylin, No 2 the mordant (iron) These solutions keep well separately   For use, equal parts of the two are mixed together   The mixture will stain at once, but is better after twenty four hours   It will keep good for eight to fourteen days

The solutions are made up as follows —

Solution 1

| Hæmatoxylin | . | . | 1 grm |
| Alcohol 96 per cent | . | . | 100 c.c. |

Solution 2

Liq ferri perchlor (S G 1 124)	4 c.c.
Dist water	100 c c.
Hydrochloric acid (conc.)	1 c.c.

The mixture, which has a brownish black colour, is dropped on to the section and allowed to remain from one to five minutes. Better results are obtained by differentiation for one or two seconds in acid alcohol (1 per cent hydrochloric acid in methylated spirit)   The section is then thoroughly well washed in tap water and counterstained with eosin or picro-fuchsin (*vide* Green's stain)

An excellent hæmatein is that recommended by Mayer
It is prepared as follows —

Hæmatein		1 grm.
90 per cent alcohol		50 c.c.
Alum		50 grm.
Water		1 litre

A crystal of thymol is added to prevent the growth of
moulds. The hæmatein should be dissolved first in the
alcohol by the aid of warmth, and then added to the water in
which the alum has been already dissolved

The stain improves on keeping   The ripening process is
more rapid if the stain be exposed to sunlight   At first it may
require half an hour or even longer to stain, later, ten to fifteen
minutes is sufficient.   If the stain is too deep or too diffuse a
few seconds in acid alcohol (hydrochloric acid 1 per cent in
methylated spirit) will differentiate.   The section is then washed
thoroughly in tap water until the blue colour returns

Method

1. Stain in hæmatoxylin for two to five minutes or hæmatein
ten to thirty minutes.

(2   Differentiate in acid alcohol if necessary)

3   Wash thoroughly in water

4   Counterstain in ½ per cent watery eosin for one to four
minutes.

5   Wash in water

6   Dehydrate, and at the same time take out some of the
eosin in absolute alcohol.

7   Clear in absolute alcohol

8   Mount in balsam

In the case of sections cut in gum or in celloidin a much
shorter period is required for staining in the hæmatein and
eosin solutions.

Hæmatoxylin combined with Picro-fuchsin (van Gieson's stain)

For this combination the hæmatoxylin or hæmatein may
be any of those in common use, such as the above mentioned,
but it is necessary when using these with picro-fuchsin to stain

for a longer period than when eosin is used, as the picric acid tends to decolourise the hæmatein Another alternative is to use a stronger nuclear stain, and for this purpose Weigert s iron hæmatoxylin has no rival.

Van Gieson's Solution—It is best to prepare a stock solution as follows :—

Acid fuchsin	1 5 grm.
Saturated watery solution of picric acid (about 0 6 per cent)	150 c.c.

This solution keeps well For use, mix 1 c.c. of the stock solution with 10 c c saturated watery solution of picric acid This solution will also keep for some weeks

Method.

1 Stain in iron hæmatoxylin for two to five minutes or in hæmatein *for fifteen to thirty minutes*

2 Wash in water

3 Stain in picro-fuchsin ten to thirty seconds.

4 Wash rapidly in water

5 Dehydrate rapidly in absolute alcohol

6 Clear in carbol xylol (or carbol benzol)

The advantages of the carbol xylol is that dehydration need not be very complete if it is used. This is of importance because prolonged treatment in alcohol extracts the stain The mixture consists of three parts xylol (or benzol) to one of melted crystalline carbolic acid

7 Clear again in xylol (in order to get rid of the carbolic)

8 Mount in Canada balsam

The special advantage of the van Gieson method is that a differentiation is effected between certain types of cells and tissues Red blood corpuscles are stained a bright yellow colour, connective tissue fibres red, and muscle fibres yellow or brownish yellow

In staining sections cut in gum or in celloidin with picro-fuchsin a longer period of washing in water is required.

Eosin, Methylene Blue Staining Method

This is a method of very general applicability In some schools in America it is used as the routine staining method,

It has many advantages It is a fairly sharp nuclear stain,
but its chief advantage is as a stain for protoplasm The
structure of the protoplasm more particularly any granules
which it may contain, are brought out with the characteristic
reaction to the acid (eosin) and basic (methylene blue) dyes
The outline of the individual cells will be brought out very
clearly and their relative size thus more easily estimated
Moreover, any bacteria present will be stained with the
methylene blue

In order to get the best results the tissue should be fixed in
Zenker's fluid or in saturated corrosive sublimate Fairly good
results will, however, be obtained with formalin fixed tissue.

Method—A simple method of using the stains is as
follows—

1 Stain in eosin (1 per cent aq solution) five to ten
minutes

2 Wash in water

3 Stain in methylene blue (1 per cent aq solution) half
minute

4 Wash in water

5 Differentiate and dehydrate in absolute alcohol.

6 Clear in xylol or benzol and mount in balsam.

After staining with the eosin, Potas. Alum (sat sol) may
be used for fixing the stain

The differentiation should be carefully carried out and
controlled by putting the section under a low power of the
microscope, and noting the point at which the nuclei of the
cells become sufficiently clear The method requires some
practice before the best results are obtained.

Mallory and Wright recommend the following—

1 Stain in eosin (5 per cent aq sol) for twenty minutes or
longer

2 Wash in water

3 Stain in Unna's alkaline methylene blue (one part in
five of water) for ten to fifteen minutes

Unna's Alkaline Methylene Blue

Methylene blue	.	.	.	1 grm
Carbonate of potassium	.	.	.	1 grm.
Water	.	.	.	100 c.c

4 Wash in water

5 Differentiate in alcohol, clear and mount

According to Mallory and Wright the success of the method depends upon the presence of colophonium in the alcohol used for differentiation. This is usually present in alcohol, but it may be necessary to add it in such quantity as to make a 10 per cent solution

A stain which gives very similar results is prepared by diluting Leishman's stain with nine parts of water   The sections are allowed to remain in this stain for twenty four hours.   They are then differentiated in a very dilute solution of acetic acid (1 1000), washed in water, dehydrated, cleared and mounted in balsam.   This makes an excellent counterstain instead of methylene blue after using Ziehl Neelsen's carbol fuchsin for staining tubercle bacilli

Pyronin Methylgreen Method (Unna Pappenheim)

This is a useful method for differentiating the various types of cells in inflammatory tissue, more especially for demonstrating ' plasma cells   The staining mixture (pyronin methylgreen) is best obtained ready made from Grubler

1 Fix in alcohol, formalin, or Orth's fixative

2 Stain in pyronin methylgreen mixture for 10-15 minutes, warming the slide slightly

3 Wash in water for several minutes

4 Differentiate in 70 per cent alcohol

5 Dehydrate rapidly, clear, mount

By the above method the protoplasm of the "plasma cells is deep red, the nucleus green

Elastic Tissue Stain

Elastic fibres enter into the formation of many tissues and organs in the body   More especially is this the case with the lungs and testicle and with vessels (other than capillaries) and skin.   In studying pathological changes in these tissues it is therefore absolutely necessary to employ some method for the demonstration of the elastic fibres.   A number of

staining methods will show elastic fibres, but for the study of changes in these fibres special *selective* methods must be employed. Of these selective methods, undoubtedly the best is Weigert's resorcin fuchsin method

The stain may be obtained in the form of powder or fluid, but it is easily prepared as follows :—

Resorcin	4 grm.
Fuchsin (Grübler)	2 grm.
Water	200 c.c.

Bring the mixture to the boil in a porcelain dish, and add 25 c.c. of the liquor ferri sesquichloridi (Pharm. Germ. S G 1 1) Boil for five minutes, stirring at the same time A precipitate forms which after cooling is filtered. This precipitate is dissolved in 200 c.c. of 94 per cent alcohol, heat being applied till the alcohol boils. The solution is then allowed to cool, made up to 200 c.c. with alcohol, and 4 c.c. of hydrochloric acid added

Method.

1 Tissues are fixed in formalin or corrosive, hardened in alcohol and cut in paraffin, celloidin, or better, in gum with the freezing microtome. It is well to cut the sections fairly thick (20-40 μ) in order that the sinuosities of the fibres may be followed Tissue hardened in alcohol must of course be washed thoroughly in water (twenty four hours) before being placed in gum

2 Stain sections in lithium carmine one to five minutes (paraffin sections twenty four hours).

Orth's Lithium Carmine

Carmine	5 grm.
Sat. aq sol. of lithium carbonate	100 c.c.
Thymol, a few crystals.	

3 Differentiate in acid alcohol (p 421) for one to twenty four hours. The longer the sections are left in this the better the result.

4 Place direct in resorcin fuchsin mixture for ten minutes (gum sections) to one hour (paraffin sections). The stain

tends to become less active in keeping, but the differentiation
is better

5 Differentiate and dehydrate in absolute alcohol   In the
case of gum sections, this is best done in a "Petri dish" so
that the section can be spread out on the slide while in the
alcohol.

6 Clear in carbol xylol or carbol benzol

7 Afterwards in xylol or benzol and mount in balsam.

By this method the elastic fibres are stained dark blue, the
cell nuclei red.   The elastic tissue stain can be used along with
other staining methods   A very good combination is the
following —

Stain in iron hæmatoxylin, then in Weigert's resorcin fuchsin,
and finish up with picro-fuchsin.

Fibrin Staining Method

Weigert's fibrin method is merely a modification of the
Weigert Gram method for staining bacteria, and sections
stained with it will also show gram positive organisms   The
method is particularly adapted for demonstrating the exudate
in acute inflammations of pleura, pericardium and lung, also
for the fibrin network in thrombi.

Method.

1 Fix in formalin or corrosive sublimate, but not in Muller's
or Orth's fluid.

2 Cut in gum, paraffin or celloidin.

3 Stain in lithium carmine (see p 426) in the case of
paraffin sections for some hours, in the case of gum or celloidin
sections for one to five minutes

4. Differentiate in acid alcohol for some time, best twenty
four hours

5 Wash well in water

6 Stain in anilin gentian violet (p 446) five to ten minutes.

7 Pour off excess and blot carefully

8 Mordant in iodine solution for two minutes.

Potassium iodide	.	.	.	5 grm
Water				05 c.c.
Iodine in excess.				

9 Pour off excess and blot firmly

10. Differentiate in anil n xylol (equal parts of aniline oil and xylol).

11 Clear in xylol, mount.

By this method the fibrin is stained blue while the nuclei of cells are stained red.

Staining of Fat in the Tissues[1]

Fat occurs in the tissues as (1) neutral fats (combinations of fatty acid and glycerine) (2) fatty acids (palmit c, stearic, or oleic) (3) soaps (combinations of fatty acids and alkalies—potassium, sodium, or calcium) (4) combinations of fat with protein (albumin soaps) All the first three varieties are demonstrable by microchemical means, the last only by chemical analysis.

In order to demonstrate fat by staining methods it is necessary to cut sections of the tissues fresh or, better, after fixation with formalin. The portion of tissue is taken direct from the formalin and frozen, or it is placed for some hours in gum (p. 408) and then cut Tissues passed through the usual reagents and cut in paraffin or celloidin have all their fat removed, unless they have been fixed previously in osmic acid, which stains certain fats black, or in a chrome salt such as bichromate of potash.

Basic anilin dyes will stain fats in the form of free fatty acid by combining with them to form coloured soaps As a rule fatty acids occur in small amount in the fat of tissues, although in some morbid conditions (e g fat necrosis) they are present in large amount The neutral fats, which are the predominant form, are, however, readily hydrolysed by the action of acids and so split into fatty acid and glycerine. The carbonic acid of the atmosphere will act in this way This hydrolysed fat will take on the basic anilin dye. In this way the fat in sections stained with such a dye and exposed to the air or to the action of an acid such as sulphurous acid gradually combines with the dye and so becomes coloured In

other words, globules of acid fat are stained immediately with
basic anilin dyes, while globules of neutral fat remain un
stained until they have been hydrolysed and the fat has
become acid

Demonstration of Fat by Hæmatoxylin. — Fat in the
tissues will stain with *hæmatoxylin*, in a similar way to myelin
in Weigert's method, after partial oxidation by fixation in bi
chromate of potash or in chromic acid   The fat, however,
takes considerably longer than the myelin to reach the stage
of oxidation at which it will "lake" hæmatoxylin

In order to stain sections of fatty liver in this way the
piece of tissue, after rapid fixation in formalin, should be cut
in gum and the sections placed in a saturated solution of
potassium bichromate at 37° C for a fortnight   At the end
of this time they are stained in Kultschitzky's hæmatoxylin,
and differentiated as on p 355, or by means of Weigert s
borax ferricyanide mixture prepared as follows —

Borax	.	.	2 grm.
Pot ferricyanide	.	2 5 grm
Water	.	100 c c,

Demonstration of Fat by Osmic Acid. —For this purpose
osmic acid 1 per cent solution in water or any of the fixatives
containing osmic acid, such as Flemming's (p 410) or
Marchi's (p 410) solutions, may be used   The action de
pends upon the reduction of the osmium peroxide to osmium
oxide   Only certain fats are blackened in this way, more
especially olein and oleic acid   The pieces of tissue treated
should be very thin as the osmic acid does not penetrate well

One advantage of the method is that the tissue can after
wards be embedded in paraffin or cellodin, although in the
case of paraffin embedding xylol should not be used   Subse
quent staining with safranin (1 per cent) gives very good
results.

The staining with osmic acid can also be carried out with
sections cut in gum   The sections are placed in a ⅛ per cent
solution of perosmic acid for 12 hours in the dark, washed
well in water, and mounted in Farrant's solution

Lorrain Smith's Nile Blue Sulphate Method —Nile blue
sulphate (4) is a dye of the oxazine series, and, like other basic

anilin dyes, it combines with fatty acid forming a coloured
soap. When sections of tissue containing fat are stained with
it, the larger proportion of the fat globules are found stained a
brilliant red, others are stained a deep blue, while others are
purple. The explanation of this is that the dye in watery
solution contains a red substance (oxazone base), which is
*derived from the blue dye (oxazine base) by a process of oxida-
tion*. This transformation can be carried out more rapidly
by heating the blue stain for some hours in the presence of
acid. This red oxazone base is readily soluble in both fatty
acids and neutral fats, and in virtue of this leaves the stain
and concentrates in the fat. *This so ution of the dye in the
fat is a rapid process.* Hence the great proportion of the fat
in the tissue will be coloured red. The blue stained globules
represent the fatty acid portion of the fat which has combined
with the basic dye (oxazine base) to form a soap. This pro-
cess is a relatively slow one.

When both neutral fat and fatty acid are present in a
globule, both stains act, thus giving a purple colour.

Method

1 Fix in formalin
2 Cut in gum with freezing microtome
3 Place the sections in a concentrated watery solution of
Nile blue sulphate for ten minutes
4 Wash in water
5 Differentiate in 1 per cent acetic acid.
6 Wash thoroughly
7 Mount in Farrant or in glycerine jelly

**Method of staining Fats with Sudan III. and Scharlach
R.**—Sudan III and Scharlach R are two anilin dyes belonging
to the azo group, closely allied to one another, the latter being
richer by two methyl groups than the former, and in conse-
quence being the *stronger stain*. Both dyes are readily
soluble in alcohol and in fat, but not in water. It is in virtue
of their solubility in fat that the colouration takes place. Both
stains are capable of colouring all types of fat—fatty acid,
neutral fat, and soaps. This fact, in conjunction with the ease
of staining, renders them the best *all round dyes* for fatty
changes. Because of its more intense staining, Scharlach R
is to be preferred to Sudan III.

Method

1 Formalin fixed tissue.
2 Cut in gum with freezing microtome.
3 Place sections in 70 per cent spirit for a few seconds
4 Then in a saturated solution of Scharlach R in 70 per cent alcohol, previously filtered, for ten minutes to twenty four hours in covered dish. (The longer the sections remain in the solution, the more intense is the staining)
5 Transfer to 70 per cent spirit
6 Wash in water
7 Counterstain for five minutes in alum hæmatein.
8 Mount in Farrant or in glycerine jelly

Owing to the fact that the stains are not very soluble in 70 per cent alcohol, a relatively long period is necessary for *perfect staining* The time can be shortened considerably by using one of Herxheimer's methods, of which the following is the best —

70 per cent alcohol	.	.	50 c.c
Pure acetone	.	.	50 c.c.
Scharlach R.	.	.	excess

In the mixture of alcohol and acetone the Scharlach R is much more soluble than in the alcohol alone Hence two to five minutes suffices for staining Care should be taken to filter the stain before use and to keep the dish covered in which the staining is carried out as otherwise precipitates may occur

Demonstration of Glycogen in the Tissues

Glycogen is a carbohydrate which occurs in cells, *e g* liver, muscle, kidney, and, more rarely, in intercellular substance It is readily soluble in water but insoluble in alcohol, therefore the tissue under examination must not be treated with water or watery stains It gives a dark brown colour with iodine For ordinary purposes Ehrlich's method is quite good
Method

1 Place tissue at once in absolute alcohol
2 Embed in paraffin
3 Stretch the cut sections in 50 per cent alcohol.

4 Place a drop of the following mixture on the slide —

Gum-arabic . . . . . 100 parts.
Lugol's iodine solution (see below) . 1 part.

Lugol's Solution

Iodine . . . . . 1 grm
Pot iodide . . . . 2 grm
Water . . . . . 300 c.c.

Place a cover glass on the specimen and investigate.

In order to obtain permanent preparations, more elaborate methods, such as Lubarsch's and Best's, must be adopted

Lubarsch's Method

1 Fix tissue in absolute alcohol, embed in paraffin, cut, stretching sections in 50 per cent alcohol.

2 Stain in Mayer's alcoholic carmine for several minutes.

Carmine . . . . . 4 grm.
Water . . . . . 15 c.c.
Hydrochloric acid . . . 30 drops.

Dissolve by boiling, add 95 c.c. of 85 per cent alcohol; filter in warm condition and neutralise with ammonia until a permanent precipitate forms, then filter in the cold.

3 Differentiate in acid alcohol (see p 421).

4 Wash in absolute alcohol

5 Stain in methylaniline violet solution as for Weigert's fibrin method (p 427), warming slightly for two minutes.

6 Wash very rapidly in water

7 Pour on Lugol's solution (see above), and leave for 10 seconds

8 Dry with filter paper

9 Differentiate in—

Anilin oil . . . . . 2 parts.
Xylol . . . . . 1 part.

10 Clear in xylol and mount in balsam.

By this method the glycogen is coloured blue violet and the nuclei of the cells red.

Best's Method

1. Fix in absolute alcohol, embed in celloidin and cut.
2. Stain in Weigert's iron hæmatoxylin (p. 421).
3. Differentiate in acid alcohol.
4. Wash rapidly in water
5. Stain in ammonia carmine prepared as follows —

Carmine					2 grm
Pot. carbonate	.	.	.	.	1 ,,
Pot. chloride	.	.	.	,	5 ,,
Dist. water	.	.			60 c.c.

Boil for a few minutes, and after cooling add ammonia 20 c.c. For use take—

Carmine solution	.	.	.	20 parts
Ammonia	.	.	.	30 ,,
Methyl alcohol	.	.		30 ,,

Stain in this for 5 minutes to 24 hours

6 Place in differentiating fluid for several minutes until the section is again *blue*   Differentiating fluid—

Abs. alcohol	.	.		40 parts.
Methyl alcohol	.	.	.	20 ,,
Dist. water	.	.	.	50 ,,

7 Wash in 80 per cent alcohol.
8 Dehydrate in alcohol, clear in xylol, mount in balsam

In the above method the hæmatoxylin may of course be omitted   Paraffin sections may be treated similarly if, after dissolving out the paraffin with xylol and washing off the xylol with alcohol, the sections are placed in thin celloidin for 3 to 4 hours   At the end of that time they are placed upon a slide and stained in Best's carmine. The glycogen by this method is stained red.

Demonstration of Calcareous Material in the Tissues

Hæmatoxylin and hæmatein stain calcareous material dark blue

Von Kossa's Silver Method

1 Fix in formalin for a short period, and cut with freezing microtome

2 Lay the sections in 5 per cent silver nitrate in the light for 10 minutes to 1 hour

3 Wash in distilled water

4 Transfer to a 5 per cent solution of sodium hyposulphite in order to remove excess of silver nitrate.

5 Wash thoroughly in water

6. As a counterstain safranin (1 per cent watery solution) may be used

7 Dehydrate, clear, mount

In carrying out the above method phosphate of silver is formed by interaction between the silver nitrate and the phosphates of calcium and magnesium. Under the influence of light the silver salt is reduced to metallic silver which appears in the section black

Stains for Amyloid or Waxy Substance

Amyloid or waxy degeneration is a change which affects connective tissue, chiefly that in relation to blood vessels

The tissue becomes swollen, transparent, and homogeneous. The material of which this degenerated tissue is composed is an albuminous body combined with chondroitin sulphuric acid.

Tissues containing waxy substance should be fixed in formalin and hardened in spirit, but should not be kept too long in either fluid, as the amyloid material tends to lose its characteristic staining properties in these fluids. It is possible, however, to stain sections successfully which have been kept for years in spirit.

Sections are best cut in gum after the spirit has been thoroughly washed out with water. The waxy material is well demonstrated by such ordinary methods as hæmatoxylin and picro-fuchsin, by which means it is stained a yellow brown

colour There are two selective methods for waxy material
—(a) iodine, (b) anilin stains

(a) **Iodine Method** The sections cut in gum are placed
in an iodine solution—Gram's or Weigert's (p 446) solutions
are both suitable—and left there for two to five minutes.
They are then mounted in glycerine jelly without washing

By this means the waxy material appears, by trans-
mitted light, a golden yellow, by reflected light a mahogany
brown.

(b) **Anilin Stains**—A number of anilin dyes, which are
mixtures of several different chemical compounds, such as methyl
violet (a mixture of tretra, penta, and hexamethyl rosanilin),
gentian violet (a mixture of the chloride of penta and hexa
methyl pararosanilin), polychrome methylene blue (formed by
boiling methylene blue with an alkali and containing methylene
violet), show characteristic staining with tissues containing
waxy material. In other words, such tissues when stained by
one of these dyes show the waxy material a pink or purple
colour while the rest of the tissue is stained blue Methyl
violet is probably the best known stain

Method—

1 Stain sections in a 1 per cent solution of methyl violet
in water for several minutes

2 Differentiate in acetic acid, 1 per cent in water

3 Wash thoroughly in water Best for twenty four hours
in several changes

4 Mount in glycerine jelly or a watery solution of levulose

Demonstration of Iron-containing Pigment in the Tissues

The sections may be fixed in formalin and cut in paraffin
or in gum The latter is best for the purpose

Method—

1 Lay the sections in a 2 per cent watery solution of
ferrocyanide of potassium for a few minutes

2 Transfer to hydrochloric acid 1 per cent in water
(acid alcohol may be used), and leave for one to two hours.

3 Wash in water

The sections may be counterstained in eosin or, better, in
alum carmine prepared as follows —

Carmine	.	.	.	2 grm.
Alum	.	.	.	5 grm.
Water	.	.	.	100 c.c.

Boil for one hour, allow to cool, and filter

Sections should be stained for ten minutes (gum or celloidin sections) to twenty four hours (paraffin sections).

Demonstration of Chromaffin Cells

In cases which had symptoms suggestive of Addison's disease during life it is necessary (p 142) to investigate the chromaffin tissue of the body   Chromaffin cells (cells, *i e*, which have an affinity for chrome salts) are found in the medullary portion of the suprarenals, in the carotid body, etc. For the demonstration of such cells the tissues should be fixed in Müller's or Orth's fluids, cut in gum, and stained in some nuclear stain, *e g* polychrome methylene blue, *to bring out the nuclei of the cells. After such treatment the chromaffin cells assume a grass green colour*

Weigert's Method for staining the Medullary Sheath of Nerves

Methods for staining the medullary sheath of nerves are all founded upon Weigert's method, which consists in fixing the tissue in potassium bichromate, fluor chrome, or some such mordant, subsequently staining in hæmatoxylin and differen tiating   Under the action of the bichromate, the myelin substance of the medullary sheath becomes partially oxidised Lorrain Smith and Mair [1] bring forward evidence to show that it is probably cholestrin in the form of a loose combination with a fatty acid which becomes oxidised during bichromating The oxidation, if not too prolonged, is only partial. There is still an unsaturated grouping   On treatment with hæmatoxylin further oxidation occurs   The oxide of chromium present in the myelin combines with the hæmatoxylin, so that "laking" of the hæmatoxylin, and therefore staining of the myelin sheath takes place   It is possible to prolong the treat ment with the bichromate to such an extent that there is

complete oxidation of the myelin substance, when no staining occurs on placing the tissue in hæmatoxylin

By this method the myelin sheath is stained a dark blue black Any axis of brain, cord, or nerve, where the myelin substance has disappeared, will remain unstained. The method is adapted for demonstrating such degenerated areas. They may be brought into greater prominence by counter staining in picro fuchsin (van Gieson's stain) when the degenerated area appears bright red

The tissue having been mordanted in potassium bichromate, *e g* in Muller's fluid (see p 409), for some six weeks, hardened in alcohol, embedded in celloidin, and cut, sections are placed in some preparation of hæmatoxylin, of which one of the best is Kultschitzky and Wolter's, prepared as follows —

Hæmatoxylin	.	.	.	.	1 grm.
Absolute alcohol	.	.	.	10 c.c.
Acetic acid (2 per cent)	.	.	90 c.c.

This solution should be prepared at least a week previous to using It keeps well, and indeed improves on keeping

Method—

1. Stain in hæmatoxylin twelve hours at 37° C.

2. Wash in water.

3. Place in $\frac{1}{4}$ per cent watery solution of potassium permanganate for twenty to thirty seconds

4. Wash in water

5. Differentiate in equal parts of sulphurous acid and water for a few minutes, *i e* until the grey matter is colourless.

6. Wash thoroughly in water

7. If desired, counterstain in picro-fuchsin (p 423)

8. Wash in methylated spirit.

9. Dehydrate in absolute alcohol.

10. Clear in benzol

11. Mount in balsam

After washing with water (2) and (6), it is advisable to leave the sections for some time (one to two hours) in water to which a small quantity of a solution of lithium carbonate has been added.

Marchi's Method for demonstrating Degenerated Myelin

In *areas of degeneration* in brain, cord, or nerve, as the result of disintegration of the myelin sheath, globules of fatty substance are set free   These globules will blacken on treatment with perosmic acid, because the fatty substances, having an unsaturated grouping, are oxidised at the expense of the perosmic acid, which is reduced to black oxide of osmium. The *normal* myelin substance of nerve tissue will act in the same way if sections are placed in perosmic acid, directly or after fixation in formalin.   On the other hand, if the nerve tissue containing the degenerated focus be exposed for a short time to the action of bichromate, the normal myelin sheath will not blacken, because oxidation of the myelin substance occurs   The globules of fat in the *degenerated* area are only slowly oxidised by the bichromate, thus reduction of perosmic acid and blackening of the globules results   As stated elsewhere (p. 429), only the olein compounds react in this way

In order to demonstrate degenerating myelin in this way a portion of spinal cord, brain, or nerve is placed in formalin for twenty four hours.   At the end of that time very thin portions are removed from the larger piece and placed in Marchi's fluid (see p 410) for three days.   They are then washed thoroughly in running water and cut in celloidin   In order to show the nuclei of the cells safranin (1 per cent) may be used

Method of demonstrating Ganglion Cells and their Nissl Bodies

For fixation, any of the fixatives may be used.   Nissl recommends absolute alcohol.   Small portions only of the tissue (brain or cord) should be taken   Fixation and hardening is complete in the alcohol in two to three days.   Nissl cuts the tissue embedded in gum arabic hardened by alcohol, but embedding in cello din or paraffin gives quite good results.

Method—

1 Stain sections in Unna's polychrome methylene blue (Grubler) for ten minutes

2 Wash in distilled water for some minutes.

3 Rinse in methylated spirit, and then in

4 Absolute alcohol to which one or two drops of acetic acid have been added, and afterwards in pure abs. alc

Differentiation may also be carried out in Unna's glycerin ether *mixture (Grubler's)* diluted *with water*

5 Clear

6 Mount   (Colophonium dissolved in xylol is recommended for this purpose)

Instead of the polychrome methylene blue, thionin or toluidin blue may be used

Method of demonstrating Neuroglia

The demonstration of neuroglia by some selective staining method is of importance in deciding the nature of tumours of the central nervous system, *i e* whether they are gliomas or not. *It is useful also in cases where increase of neuroglia tissue is* suspected, as in scars following softenings and hæmorrhages and in the more diffuse gliosis of general paralysis, Huntingdon's chorea, etc.   All the methods are somewhat uncertain in their results, and even successful preparations are apt to show areas which are poorly stained   One of the simpler and more reliable methods is Mallory's

The tissue must be fixed in Zenker's fluid for twenty four hours, either at once or after twenty four hours in formalin

Wash well for twenty four hours in running water

Pass *through varying strength of spirit dehydrate*, clear and embed in paraffin or celloidin.

Sections are then treated with iodine solution to remove the mercury

Wash thoroughly, changing several times, in 95 per cent alcohol to remove all trace of the iodine

Wash in water

Treat with $\frac{1}{4}$ per cent potassium permanganate *for five* to twenty minutes

Wash in water

Treat with 5 per cent oxalic acid five to twenty minutes

Wash thoroughly in several changes of water

Stain in phosphotungstic acid hæmatoxylin for twelve or twenty four hours

Mallory's Phosphotungstic Acid Hæmatoxylin

Hæmatein ammonium   0 1 grm.
Water   100 c c
Phosphotungstic acid crystals (Merck)   2 grm

Transfer directly to 95 per cent alcohol, and dehydrate rapidly with absolute alcohol   Clear in xylol and mount in Canada balsam.

MAKING OF BLOOD FILMS

(a) Take some perfectly clean slides   Knock off the corner of one of them (so that the end measures a little less than one inch) by making a small scratch with a glass cutter   Place a small drop of blood at the end of another slide and with the broken end of the first guide the drop along the surface   In this way a thin film of blood will be obtained which reaches not quite to the margins of the slide on either side.

(b) Take a number of perfectly clean square No 2 cover glasses   Place them on filter paper   Lift one of them with a pair of small forceps and remove from the pricked finger or ear a very small drop of blood.   (The size of the drop required depends upon the size of the cover glass, only experience will teach the operator)   Allow this cover glass to rest upon another, the drop of blood being between and the angles of the slips not coinciding   The weight of the upper cover glass will spread the blood, and if both slips be clean an even film will be obtained   The lower cover glass is then lifted by means of the forceps by one of the projecting angles and grasped between finger and thumb by two opposite angles   The upper cover glass is then grasped at a projecting angle by the forceps and gently slid off the lower

Each film is then allowed to dry in the air   The forceps used should be preferably non serrated at the points.

Staining of Blood Films.—For ordinary purposes this is best done by Jenner's, Leishman's, or Wright's stains   In each case the stain is an eosinated methylene blue dissolved in pure methylic alcohol.   The stains may be bought ready made

up, or tabloids prepared by Burroughs, Wellcome, & Co may be used   These should be dissolved in 10 c.c. of methylic alcohol.   *No preliminary fixation is required as the methylic alcohol acts as a fixative*   The action of the stain can be limited by drawing two lines across the slide with a grease pencil

Leishman's and Wright's Stains—

1 The stain is poured on to the film and allowed to remain for one to two minutes

2 Add an equal quantity (*circa*) of distilled water by means of a glass pipette.   Mix by gently rocking, and leave for three to five minutes

3 Pour off the stain and add from time to time distilled water, rocking the specimen to and fro until the thinner portions become pink.

4 Pour off the water and allow the film to dry in the air

These stains are also excellent for demonstrating parasites, such as malaria, trypanosomes, etc.

Jenner's Stain—

1 Pour on stain and leave for two to four minutes

2 Wash off with distilled water, controlling the differentia tion by examining under the microscope

3 Dry in the air, placing in a sloping position.

BACTERIOLOGICAL METHODS OF INVESTIGATION

Requisites

A bunsen burner or, in the absence of gas, a spirit lamp should be close at hand   A number of sterile pipettes made by drawing out suitable glass tubing in a blow pipe, and rubber teats, a looped platinum needle, a flat piece of metal for searing organs, a rack with culture tubes (broth and agar and blood agar slopes), and a number of clean slides should be within reach   When culture tubes are not available, several sterile test tubes, or, better, sterile swabs in test tubes for removing samples of exudate, will serve the purpose.   In his laboratory the pathologist should, of course, have an incubator, dyes for staining, etc., etc.   A pencil for writing on glass will be found useful

Method of inoculating Culture Tubes

Sterilise the platinum needle by holding it obliquely in the flame. Turn round the cotton wool plug of the culture tube to be inoculated so as to ensure its easy removal. Holding the platinum needle in the right hand like a pen and the culture tube in the left, remove some of the exudate or pus, an assistant holding open with forceps the incision previously made into the serous sac, abscess, or organ. Grasp the cotton wool plug between the right ring and little fingers and remove it. Smear the surface of the agar tube with the exudate. In the case of the broth tube, rub the loop of the needle against the side of the tube at the upper level of the fluid.

Owing to the fact that bacteria of all kinds rapidly invade the body after death, chiefly from the alimentary canal, bacteriological investigations carried out upon the cadaver are not nearly so reliable as those performed during the life of the patient. Pathogenic microbes tend to die out and their place to be taken by the unimportant saprophytic forms which have invaded the tissues. At the same time, where cultural investigations have not been made during life, or where the affected focus is in a part of the body which ordinary clinical methods could not reach, it becomes necessary for the pathologist to elucidate as far as he can the bacteriological aspect of the diseased condition. Although, as we have seen, it is advisable to carry out the examination as soon as possible after the death of the patient for ordinary purposes, it is doubly so when the pathologist has in view any bacteriological investigation. The bacteria which invade the tissues multiply and spread at such a rapid rate that ultimately any exact bacteriological observations become impossible.

Examination of the Blood

This is, of course, best done during the life of the patient by drawing off 1·5 c.c. of blood from one of the arm veins. In cases of bacteriæmia, when this has been omitted during life, it is still possible to carry out the observation after death. Unfortunately the blood is the tissue of the body most rapidly

invaded by the saprophytic germs   Nevertheless, when carefully done, the investigation is undoubtedly useful.

It has been shown by Canon[1] that it is the blood in the peripheral veins which gives the most reliable results, much more reliable than in the case of the heart

A large vein in the arm should be exposed by cutting through the skin, incised with a sterile knife, and by pressing down from above, a fair amount of blood or blood serum can be collected in a syringe or pipette   The fluid is then added to one or more broth tubes, or smeared over an agar slope, and incubated

The blood may also be obtained from the heart or from the interior of one of the solid organs, such as the spleen, as will be detailed later

Examination of the Solid Organs

The spleen in typhoid fever, the lung in pneumonia, the liver in cases of abscess formation, the brain in meningitis may be examined in this way

The surface of the organ is seared by means of a red hot flat piece of metal   A useful instrument for this purpose is a copper section lifter   A knife is sterilised either in the flame or by boiling, and a cut is made into the substance of the organ through the seared portion of the surface   A platinum loop is then inserted through the opening, pushed further in if that is possible, withdrawn, and then smeared over the surface of an agar slope or shaken in a broth tube

Smears on slides may also be made from the solid organs, more especially spleen or lung, and stained to demonstrate bacteria

Examination of Contents of Hollow Viscera

Bacteriological examination of the intestinal canal is seldom of much use, owing to the multiplication of the organisms of putrefaction   In certain cases however, useful information may be obtained.   In typhoid fever, for example, pure cultures of the bacillus typhosus may be obtained from the upper part of the

[1] Die Bakteriologie des Blutes bei Infektionskrankheiten Jena 1905

jejunum as well as from the urinary bladder and gall bladder
In opening these viscera for such a purpose, it is well to sear
the surface, incise with a sterile knife, and remove a sample of
the contents with platinum loop or pipette

Examination of the Contents of Serous Sacs

This is usually the first and the commonest bacteriological
problem which the pathologist encounters. Where the presence
of pus is suspected in one of the serous sacs, it is necessary to
open the sac with certain precautions

Having dissected down to the lining membrane—pleura,
pericardium, peritoneum, as the case may be—a clean knife
(bistoury) and pair of dissecting forceps are taken, the
membrane is raised with the forceps and a small incision
made   Through this a sterile platinum loop or a pipette is
inserted, a small quantity of the fluid removed and inoculated
into a series of culture tubes.

As a rule, the media employed will be broth or agar slope,
and where the presence of one of the more delicate germs is
suspected, such as the streptococcus, pneumococcus, or influenza
bacillus, blood agar or blood serum. Subsequently, a number
of films from the fluid should be made and stained.

Where the cavity has been already opened into, that is,
before its infected nature was realised, pressure should be exerted
upon the deeper parts so that some fresh fluid appears, and as
this flows over the edge of the opening a sample for inocula
tion may be obtained by means of a platinum loop or pipette.

Blood agar culture media may be readily obtained from
ordinary agar slopes by smearing with a platinum loop a little
blood from the finger over the surface   The finger should be
first rubbed at the root of the nail with a little methylated spirit
which is allowed to dry   A sharp stab is then made by means
of a sharp pointed knife similarly sterilised, a cloth being
wrapped round the finger to congest it.

Method of making Films from Pus and Sputum

When the pus or sputum is thick, an excellent method is
to place a drop of the fluid on a clean slide, place another

on the top until the pus has spread between the two, then slide them rapidly apart   In this way two good films are obtained Another method is to spread the fluid with the platinum needle laid flat on the glass

The film is then dried by moving it to and fro well above the bunsen flame, and ultimately fixed by passing it thrice through the flame.   Another method of fixation is by means of absolute alcohol.   The alcohol is dropped on and left for some minutes, after which it is washed off in water   Still another fixative for films is the following mixture :—

| Methylated spirit | 9 parts. |
| Formaldehyde | . 1 part |

This is dropped on and left for thirty seconds to a minute, and then washed off with water

Staining Methods for Bacteria

Bacteria are composed of a large extent of nuclear material Thus when it is desired to demonstrate them microscopically, they are stained with nuclear dyes   Hæmatoxylin and similar dyes, however, only stain organisms faintly   It is the basic anilin dyes which are most commonly used for this purpose, such as methylene blue, gentian violet, basic fuchsin.

As a rule, bacteria do not take up these dyes nearly so readily as the nuclei of cells   In consequence, it is necessary to enforce their action by (a) allowing the stain to act for a prolonged period, (b) by heating, or (c) by the addition of some mordant to the stain, such as carbolic acid, caustic potash, anilin oil.   Once stained, however, the bacteria retain the dye with much more persistence than the nuclei of cells amongst which they may lie.   Hence it is possible by the use of a decolourising or differentiating agent, such as alcohol or some dilute acid, to bring the bacteria into greater prominence and differentiate them from the surrounding stains   This resistance to decolourising agents is more marked in a group of bacteria which includes the tubercle bacillus   In con sequence, the term "acid fast" is applied to them   The tubercle bacillus, after having been stained, resists also the decolourising action of alcohol as well as of acid.

Gram's Method and Weigert's Modification

1 Fix film.

2 Filter on to film or section anilin or carbol gentian violet made up as follows —

Saturated solution of anilin oil in water or carbolic acid 1 to 40	9 parts.
Saturated alcoholic solution of methyl or gentian violet	1 part

For films of bacteria or pus this should be left on for two minutes

For sections of tissue it should remain five minutes

3 Wash in water

4 Pour on Gram's or Weigert's iodine solution The latter is three times the strength of the former and is better for this reason It is prepared as follows —

Iodine	.	.	excess
Potassium iodide	.	.	5 grm.
Water	.	.	100 c c.

The iodine is left on for one minute in the case of films, for two minutes in the case of sections

5 Differentiate in methylated spirit

Some experience is required before this can be done successfully A few seconds is usually all that is required for films In the case of sections, not quite all the blue should be removed.

A better method with sections is to blot the section firmly but carefully with filter paper after the iodine Then drop on anilin xylol (equal parts of anilin oil and xylol) This may be allowed to act until all the blue has been removed. Rapidly treat with spirit to remove the anilin xylol

6 Wash in water

7 *Counterstain for half a minute in some red or brown stain,* such as fuchsin, safranin, Bismarck brown, or lithium carmine considerably diluted.

8 Wash in water

9 In the case of films, dry them well above the flame. In

the case of sections, dehydrate, clear, and mount in Canada balsam.

Carbol-Thionin Blue

1 Filter on staining solution consisting of 1 gramme thionin blue dissolved in 100 c c. carbolic (1 to 40) The author has found this stronger solution preferable to the dilu tion of the above, in the proportion of 1 of the stain to 3 of water, recommended by Muir and Ritchie

Films should be stained for three to five minutes, sections from five to ten minutes.

2 Wash in water

In the case of films, blot, dry, and, if necessary, mount

In the case of sections and thick films of pus

3 Decolourise very rapidly in 1 per cent acetic acid in water

4 Wash in water

5 Dehydrate, clear, and mount.

The above is an excellent method for demonstrating the ordinary bacteria in films from cultures, in pus and in tissues. It is specially suitable for showing up masses of typhoid bacilli in spleen and mesenteric glands, *bacillus coli* in liver, *bacillus pestis* in spleen or bubo, *entamœba hystolytica* in dysentery, etc.   The organisms stain a deeper purple than the nuclei of the cells   Red blood corpuscles in properly stained specimens are yellow

Where the organisms are too readily decolourised, as in the case of *bacillus pestis* sometimes, after staining, instead of washing in water and decolourising, blot the specimen and pour on some aniline oil and rock the slide to and fro until the greater portion of the stain has come out, then use xylol and mount in balsam

This staining method may also be used for demonstrating mucus which takes on a red or purple colour with Thionin blue.

Eosin Methylene Blue

This method is given above (p 424). It is well adapted for demonstrating masses of cocci in vegetations, diphtheria

bacilli in false membrane, abscesses, etc., also entamœbæ in the large bowel or liver

Both this method and the previous one have this advantage over Gram's method that the cells and intercellular fibres of the tissues and bacteria are stained more naturally   In Gram's method the organisms appear often abnormally large, and the tissues tend to be altered by the iodine

Staining Methods for the Tubercle Bacillus

A. Ziehl Neelsen Method

1 Filter on the following stain usually known as Ziehl-Neelsen's carbol fuchsin stain —

Basic fuchsin	.	.	1 part.
Absolute alcohol	.	.	10 parts
Carbolic acid in water (1 20)			100 parts

Instead of the carbolic (1 20) a saturated solution of anilin oil in water may be used   This should of course be filtered previous to making up

The best way is to keep in a stock bottle absolute alcohol saturated with basic fuchsin   This is added to the carbolic water as required

In the case of films, hold over flame or place upon hot metal slab or coin while steam rises   Remove the specimen and repeat the process twice, the staining occupying three to five minutes

In the case of sections, the above method may be used, the staining process occupying at least five minutes.

The author has, however, found that placing the sections in the carbol or anilin fuchsin in a jar in the paraffin bath at 50-55° C gives much better results, the tissues being less damaged by the heating

2 Wash in water

3 Differentiate in 1 per cent hydrochloric acid in methylated spirit. This the author has found very much better than the usual 25 per cent H_2SO_4 *in water   The advantages*

are that there is no danger of decolourising, the alcohol test is applied to the organism at the same time as the acid, and, in the case of sections, the tissues are not damaged as they certainly are by the stronger acid   Differentiation should be carried out until there is just a slight pink tinge in the film or section   Thick portions of the film will probably be still red, but in any case, in searching for tubercle bacilli, such thick areas should be avoided

4   Wash in water

5   Counterstain in a 1 per cent watery solution of methylene blue for half a minute

With sections, diluted Leishman's stain gives excellent results   One part of Leishman's stain is added to 10 of ordinary tap water, the section is left in this in a jar over night   It is then differentiated rapidly in acetic acid (1 1000), dehydrated, cleared, and mounted

6   In the case of films, wash in water, blot, dry, and mount

In the case of sections, dehydrate thoroughly, thus removing excess of methylene blue, clear in xylol or benzol, and mount in balsam.

B   Much Gram Method

1   Stain film in the following mixture, either heating above the flame for a few minutes till steam rises or leaving in the incubator at 37° C for twenty four to forty-eight hours —

    Saturated alcoholic solution of methyl
       violet B N   10 c.c.
    2 per cent water solution of carbolic acid   100 c.c.

2   Apply Gram's iodine for one to five minutes

3   Drop on 5 per cent nitric acid and leave for one minute.

4   Drop on 3 per cent hydrochloric acid and leave for ten seconds

5   Differentiate in acetone and alcohol equal parts.

6   Wash in water.

7   Counterstain in dilute fuchsin if required.

8. Wash, dry.

More recently Much has used instead of 2, 3, and 4 the following mixture:

| Potassium iodide | 5 grm. |
| 2 per cent hydrogen peroxide | 100 c.c. |

The film is then differentiated in absolute alcohol.

By either of the above methods, in addition to the ordinary form of the tubercle bacillus which is demonstrated by methods such as Ziehl Neelsen's, a granular form of the organism which appears as minute blue black granules is shown. This form is believed by many to be a resting stage or spore form of the bacillus. The granules may occur in a bacillary form or may be found free.

C Method combining Ziehl Neelsen with Much Gram (Much Weiss)

1 Stain in the following mixture for twenty four to forty eight hours:

| Much's carbol methyl violet solution | 1 part. |
| Carbol fuchsin | 3 parts. |

Subsequently treat with iodine, nitric acid, etc., as in the Much Gram method.

Method of demonstrating the Club Form of Streptothrix Actinomyces

These bodies are exceedingly variable in their staining reactions. They are sometimes demonstrable by means of Gram's method, but they are more often decolourised. The author has introduced the following method, which has the advantage of bringing the bodies out in striking contrast to their surroundings.

The tissues may be fixed in either 10 per cent formalin or in saturated corrosive sublimate. The section is placed in the following mixture, which is known as Mann's methyl blue and eosin stain:—

1	1 per cent methyl blue in distilled water	.	35 c.c.
	1 per cent eosin in distilled water		45 c.c.
	Distilled water	.	100 c.c.

The section should be left in this for twenty four hours   A few hours would suffice, but in order to obtain the best results, the longer period is necessary

2 Wash in water

3 Dehydrate in absolute alcohol to which a few drops of a 1 per cent solution of caustic potash in absolute alcohol has been added

Treat the specimen with the above reagent until it becomes a bright pink colour

4 Wash in 1 per cent acetic acid in water   The section will now become bright blue

5 Wash in water

Examine under microscope, and if necessary repeat 3 and 4

6 Dehydrate, clear, and mount

The above method is a slight modification of Mann's methyl blue and eosin stain   By means of it the clubs will be stained a bright red colour, while the cells surrounding them, as well as the mycelium on the fungus, stain blue   The stain is not absolutely specific, as red blood corpuscles and inflammatory exudate as well as the granules of eosinophil leucocytes and pancreatic cells react in a similar fashion.

Method for staining the Capsules of Bacteria

The following is a slight modification of Muir's capsule method, suggested by Dr F E Reynolds   It is useful for staining the capsule of the pneumococcus or pneumobacillus in blood, sputum, or pus films —

1 Stain in Carbol fuchsin, steaming, for one minute

2 Wash well in water

3 Apply Muir s mordant for one to two minutes

Muir's mordant is prepared as follows —

Saturated solution of corrosive sublimate	2 parts
Tannic acid (20 per cent solution)	2 parts
Saturated solution of potash alum	5 parts

4 Wash well in water

5 Differentiate in methylated spirit for one minute.

6 Wash well in water

7 Stain in methylene blue for one to two minutes.

8 Wash in water

9 Dehydrate quickly in absolute alcohol

10 Clear in xylol or benzol for five minutes.

11 Mount in Canada balsam.

By this method the organisms are stained red, while the capsules of the bacteria, the pus cells, etc., are stained blue.

Hiss's Method

1 Stain in the following mixture, heating for a few seconds over the flame until steam rises.

| Saturated alcoholic solution of acid fuchsin | . | 1 part |
| Distilled water | . | 19 parts. |

2 Wash off the staining fluid with a 20 per cent solution of copper sulphate

3 Without washing in water dry with filter paper

By this method the capsules of organisms growing in both as well as these in blood and pus films can be demonstrated.

Methods for demonstrating Spirochætes

In Films:—

(1) Giemsa's Method.

1 Make a thin film of the fluid to be examined.

2 Fix it in absolute alcohol for fifteen minutes

3 Dilute Giemsa's stain by adding 10 drops to 10 c.c. distilled water and pour over film, leaving for ten to thirty minutes.

4 Wash well in a stream of water and dry.

(2) Burri's Ink Method.

For this purpose a little "Chin-chin, Pelican" ink is mixed with an equal quantity of distilled water   This mixture should be sterilised in the autoclave and allowed to sediment for some time (two weeks)   It is then decanted off the

sediment   With a platinum needle a small quantity of the
fluid to be investigated is mixed with a little of the ink on a
clean slide and a film made   This is allowed to dry and is
then examined with the oil immersion lens

In Tissues—

For this purpose Levaditi s method gives excellent results

1   Thin pieces of the tissues are placed in 10 per cent
formalin for twenty four hours

2   Transfer to 96 per cent alcohol for twenty four hours

3   Place in distilled water until they sink.

4   Transfer to $1\frac{1}{2}$-3 per cent solution of silver nitrate in
distilled water and leave there for three days in the incubator
at 37° C

5   Wash rapidly in distilled water

6   Reduce by placing for twenty four to forty eight hours
at room temperature in the dark in

Pyrogallic acid	. .	4 grm
Formalin (40 per cent)	.	5 c c
Distilled water	.	100 c.c.

7   Wash in water

8   Embed in paraffin or celloidin

After cutting the paraffin sections merely require solution of
the paraffin and mounting in balsam

By this method the spirochætes appear black, from the
silver which is precipitated in their substance.

EXAMINATION OF SPUTUM, PUS, ETC,
FOR THE TUBERCLE BACILLUS

The sputum should be poured into a Petri dish, and by
means of sharp pointed forceps and scissors a suitable portion
is removed and placed upon a clean slide   A second slide is
placed upon the top of the first and the sputum spread out by
pressing the slides together   The two slides are then slid
apart and the two films dried and fixed in the flame   Suitable
portions for examination are any rounded yellow or white

masses, or, in the absence of these, opaque white streaky material Both slides are then stained with carbol fuchsin for three to five minutes, the stain being heated until the steam rises A convenient way of doing this is to heat a penny in the flame and then place the slide covered with carbol fuchsin upon the coin. Where a number of slides have to be stained at once a useful method is to place two pieces of glass tubing across a sink, the slides are then placed across these, the stain is filtered on, and the slides heated by playing a bunsen flame on them from below Having been stained, the films are washed in water and differentiated in a 1 per cent mixture of hydrochloric acid and methylated spirit This medium for differentiating has the advantage that the alcohol and acid test are applied at one and the same time. The slide is then washed in water, counter stained in methylene blue (1 per cent watery), washed again in water, dried, and examined under the oil immersion. It is well to examine both slides systematically from one end to the other

Pus or caseous material may be examined in a similar way

The reason for differentiating with acid is because a majority of organisms, after staining in carbol fuchsin and heating, are readily decolourised with dilute acid. The tubercle bacillus and other germs, such as the bacillus of leprosy, the smegma bacillus, the Timothy grass bacillus, the butter bacillus, etc., are not decolourised with dilute acid They thus form a group of acid fast bacilli Spirit or alcohol forms another differentiating medium, because the tubercle bacillus resists it, whereas the smegma bacillus is decolourised

Concentration Method for Sputum, Pus, etc.

Add to the sputum, pus, etc. an equal quantity of 50 per cent antiformin.

Antiformin may be made up as follows —

Solution 1

Sod carb	. .	10 grm
Calx chlorinata (bleaching powder)	.	50 grm.
Dist. water	. . . .	100 c.c.

Solution 2

Sod hydrate	.	.	15 grm
Dist water			100 c.c.

For use mix equal parts of 1 and 2, and dilute with equal quantity of water

The mixture is then shaken thoroughly and allowed to remain for two to twenty four hours. At the end of that time it will form a more or less homogeneous fluid. This may be centrifugalised at once and the deposit examined by staining, or Eurich's method may be employed as follows :—Acetone and ether (equal parts) are shaken up with the antiformin mixture in a narrow glass vessel. The fluids will then separate into two layers, the acetone and ether being above, and at the point of junction a white precipitate, *which contains the larger proportion of any cellular debris* in the sputum, also the micro-organisms and among these the tubercle bacilli. The precipitate is easily removed (after pipetting off the ether) by means of a glass pipette and rubber teat. Films are made from this, stained, and examined. In cases where no precipitate forms at the junction of the fluids, the acetone and ether should be decanted off, and some of the antiformin mixture centrifugalised The films are made from the deposit. Should such deposit be found difficult to spread on a slide, a little of the original sputum mixed with it will assist matters.

Caseous tissue should be cut up into thin shreds by sectioning with the freezing microtome and the resulting pulp treated with antiformin and centrifugalised The deposit is then smeared on slides and stained by the Ziehl Neelsen or Much Gram method.

Care should always be taken to see that any distilled or tap water used in carrying out these processes is itself free from acid fast organisms

THE BACTERIOLOGICAL DIAGNOSIS OF DIPHTHERIA

It may be necessary in some fatal cases of disease to ascertain whether or not diphtheria bacilli are present in the

fauces, tonsils, or mucous membrane of the air passages   The
method of diagnosis is the same as in the case of the living
subject, and should be carried out as follows —

(a) Films should be made from suspicious exudate in any
of the above situations and stained by (i.) Gram's method, (ii.)
carbol thionin blue   (iii.) Neisser's method (see below)   Char
acteristic organisms may or may not be found. If none are
seen, cultures should be made

(b) A sterile swab or platinum needle is rubbed over the
surface of any exudate which may be present. If no exudate
is present, the secretion covering the tonsil is removed and
smeared over the surface of a tube of blood serum or blood
agar   This is incubated at blood heat for 12 to 24 hours
Films are then made from the growth which develops, and
stained by the above methods.

Neisser's Staining Method for the Diphtheria Bacillus

Solutions

A. Methylene blue (Grubler), 1 grm, dis-
   solved in 20 c.c. of 96 per cent alcohol.
   Add to this 950 c.c. of distilled water
   and 50 c.c. glacial acetic acid.
B. Bismarck brown (Vesuvin) . 2 grm.
   Distilled water . . 1 litre

Method.

Stain films for one to three seconds in A, pour off the
excess of stain and blot. Drop on B and leave for three to
nine minutes. Wash, dry and examine

By this method the body of the diphtheria organism is
stained brown while the granules are dark blue

A modification of the method is as follows —

Prepare two staining fluids

A Methylene blue . . . 1 grm
   96 per cent Alc . . 20 c.c.
   Glacial acetic acid . 50 c.c.
   Distilled water . . 1 litre

B Crystal violet (Hochst)   .   1 grm.
    Abs alc.   10 c.c.
    Distilled water   .   300 c.c.

Mix two parts of A with one of B

Method.

1 Stain in mixture for about ten seconds.

2 Wash in water

3 Stain in cresoidin (2 grm in 300 c.c. water) for about ten seconds (the stain should be dissolved in hot water and filtered).

4 Wash, dry, and mount.

The appearance of the organism is the same as with the first method.

Laybourn's modification of Albert's stain (*Journal of Amer Med Assoc*, July 12, 1924, p 121) gives excellent results The solutions are made up as follows —

Solution 1

Toluidin blue		0 15 grm
Malachite green	.	0 20 grm.
Glacial acetic acid	.	1 0 c.c.
Alcohol (95 per cent)		2 0 c.c.
Distilled water		100 c c.

Allow to stand twenty four hours and filter

Solution 2

Iodine	.	.	2 grm
Pot. iodide	.	.	3 grm
Distilled water			300 c.c.

Technique

1 Make smears

2 Apply solution 1 for three to five minutes.

3 Wash in water

4 Solution 2 for one minute

5 Wash in water

6 Dry and examine

AGGLUTINATION TEST FOR ORGANISMS

It is sometimes necessary to carry out an agglutination test in the case of an organismal condition such as typhoid fever

(Widal reaction), or in cases of suspected meat poisoning (see p 396), the serum of the individual being tested as regards its agglutinating power against the germ or germs cultivated from the lesion or from intestinal contents or against stock cultures of known organisms.

The method of carrying out the microscopic test is as follows —

1 The *serum* of the case is secured by centrifugalising a quantity of blood or blood-clot obtained from the heart and pipetting off the supernatant fluid. This is mixed with normal saline solution by means of a graduated pipette so as to make dilutions of 1 in 5, 1 in 20, and 1 in 40, etc.

Another method is to prepare a capillary pipette (see below), make a mark upon it with a grease pencil, and draw up, by means of a rubber teat, to the mark one portion of the serum and subsequently four portions of the normal saline solution, allowing a bubble of air to intervene between the various portions These are then blown out and mixed in a watch glass, thus forming a dilution of one in five. From this the other dilutions can be made in a similar fashion.

2 A *pure culture* on solid medium, e.g agar slope, of the organism against which it is desired to test the serum is obtained. An emulsion is made by mixing some of the growth, removed by a platinum needle, in normal saline, thus making a solution with a distinctly opalescent, but not too turbid, appear ance This is allowed to settle for an hour, or centrifugalised for a few minutes, in order to get rid of any clumps of bacteria.

A slide with a hollow in the centre is then taken and smeared round the margin of the hollow with vaseline A cover slip is cleaned, and by means of a platinum loop a minute spot of the serum (1 in five) and one of the emulsion are placed side by side on the cover glass, and, after heating the loop in order to dry it and allowing it to cool, the two are mixed together The cover slip is then lifted with a pair of forceps, turned over, and placed upon the slide so that the drop hangs in the hollow The slide is examined under a ⅛ objective, care being taken to cut off the greater part of the light coming from the mirror of the microscope, by means of the iris diaphragm. The organisms will usually be seen as minute highly refractile bod es, darting hither and thither Similar hanging drop

preparations should be made with the other dilutions of the
serum   Dilutions of 1 in 10, 1 in 40, and 1 in 80 are thus
obtained   Control preparations may also be made with a
normal serum

After examining the slides under the microscope to see that
the bacteria are visible and motile they should be placed in
the incubator and again examined after one half to one hour
The presence of clumps of motionless bacteria is indicative of
a positive reaction.   At the same time a positive result with a
dilution of 1 in 10 should be neglected unless there is agglutina
tion in the higher dilutions as well

In the absence of the hollow slides, ordinary slides may
be used

The *macroscopic* test is carried out as follows —

A series of seven small clean test tubes are put in a rack.
Sterile salt solution is added in the following amounts
0 8 c c. to the first tube, 0 5 c.c to the others.   Pipette
0 2 c.c. of the serum to be tested into the first tube, mix and
add 0 5 c.c. of the mixture to the second tube   Repeat the
process in the cases of the other tubes as far as the sixth.
To the seventh tube add 0 5 c.c. of saline.   To all tubes add
0 5 c.c. of suspension of a young culture of *B typhosus* or a
culture killed by heat or by the addition of formalin.   The
dilutions of the serum in the first six tubes will be 1 10, 1 20,
1 40, 1 80, 1 160, and 1 320   The seventh tube is used
as a control   Place the mixtures after shaking in a water bath
at 55° C. for one to two hours, and note the tubes in which
clumping of the organisms has occurred as indicated by
suspended floccul, or, in more marked cases, by a definite
precipitate at the bottom of the tube.

METHOD OF MAKING PIPETTES FOR REMOVING FLUIDS, ETC

Mark off a section, 6-8 inches long, of soft glass tubing
($\frac{1}{4}$ inch bore) with a file and break it across.   This is held in
the hands so that the centre lies in the flame of a blow pipe
or an ordinary Bunsen burner, the tubing being constantly
turned between the fingers so that the flame plays upon all sides
of it.   No attempt should be made to draw the two ends

apart until the central portion is quite soft. When this has been effected the tube is withdrawn from the flame, and very slowly the two ends are separated, until a capillary tube of at least 12 inches long has been made. The tubing should be held in the same position until it has cooled sufficiently to prevent its bending. It is then broken across in the centre thus forming two pipettes. The end of the pipette should be passed through the flame before using for the removal of exudate, blood, etc. A rubber teat attached at the broad end will enable the operator to withdraw a considerable quantity of fluid.

APPENDIX B

EMBALMING

In cases where bodies have to be sent long distances, it may be necessary to inject a preservative into the circulation in order to stay the progress of putrefaction. The simplest fluid for the purpose is made up as follows —

Formalin	4 pints
Acid-carbolic (cryst.)	1 lb.
Water	2 gallons.

This fluid, to the amount of two gallons (in the case of an adult male), should be introduced by means of a cannula into the femoral artery or abdominal aorta. The time selected for the operation should be at least twenty four hours after death, i e at a time when rigor mortis has just passed off. If the femoral artery is selected, the injection should be made in Scarpa's triangle, and the nozzle of the injector directed upwards towards the heart.

If a post mortem examination has to be performed in addition, this should be carried out at least twenty four hours after the injection.

Preservative fluid should also be introduced into the stomach, intestines, bladder, pleura, and other spaces.

The surface of the body may, in addition, be washed with a saturated solution of corrosive sublimate in methylated spirit mixed with five times the amount of glycerine. (C R. Lox, *Post-Mortem Manual.*)

INDEX

THE END

FIG 1 —Method of opening the abdominal cavity
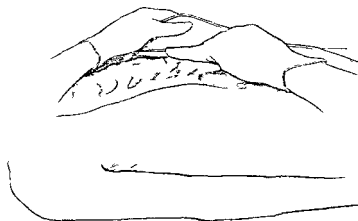
FIG 2 —Reflecting the skin and muscles from the sternum and ribs
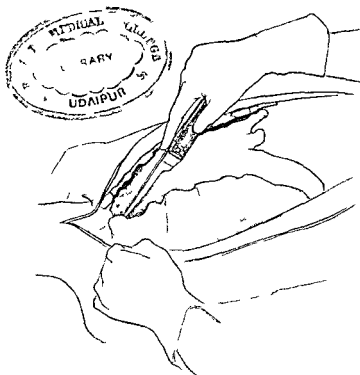
FIG 3 —Method of cutt ng through sterno clav cular jo nt.
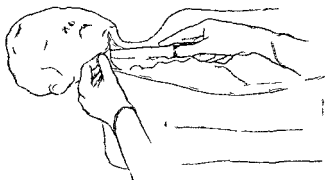
FIG 4 —Metho l of cutt ng through floor of mouth
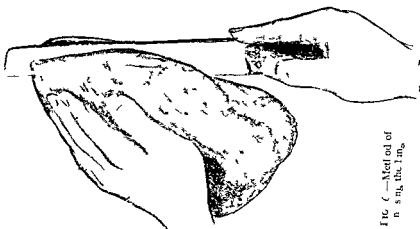
FIG. 5.—Methods of opening up the chambers of the heart.
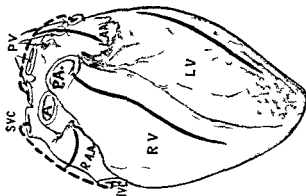
IVC, inferior vena cava; SVC, superior vena cava; RA, right auricle; LA, left auricle; RV, right ventricle; LV, left ventricle; PA, pulmonary artery; PV, pulmonary vein.

FIG. 6.—Method of opening the lung.

FIG. 8.—Method of testing the competence of the semilunar valves
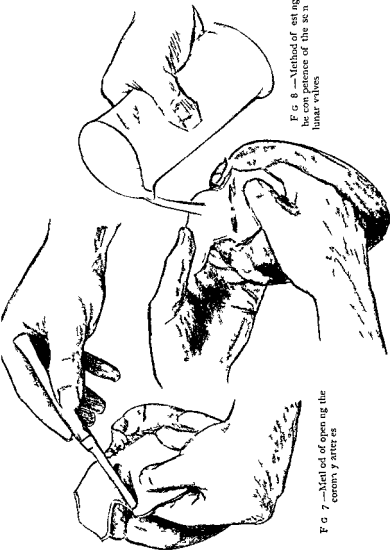
FIG. 7.—Method of opening the coronary arteries
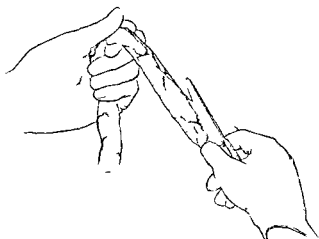
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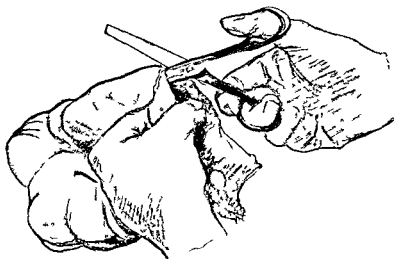
FIG 10 —Method of opening the bowel after it has been removed

FIG 12
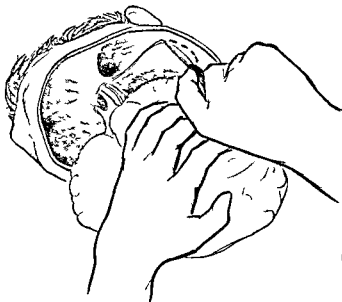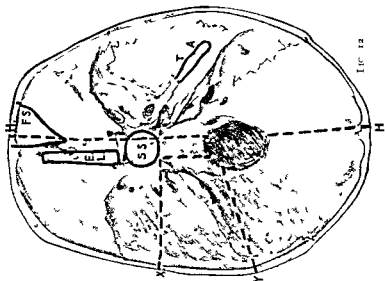
FIG 11

FIG 11 —Cutting through tentorium cerebelli

FIG 12 —Location of the accessory canals in relation to the base of the skull
S, foramen lacerum; h, the hole in the maxillary; S, sphenoidal sinus; n, od ant m
H, II saw incline plane; r, L, the medial lymph node; V, sawline for removing temporal lobe
new for separating the base of skull according to Flatau's method
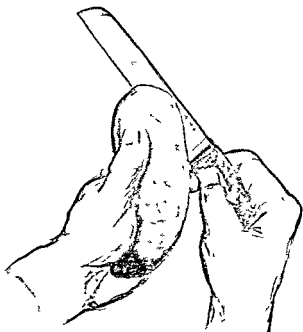
FIG 13 —Method of incising the kidney
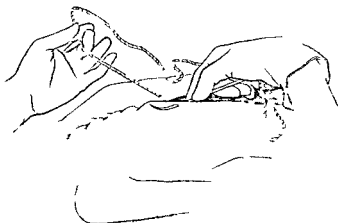
FIG 14 —Method of stitching up

FIG 16.—Acute aneurysm following abscess of left ventricle in a case of Osteomyelitis Posterior view ½

The photograph was taken with the left ventricle laid open, showing the common cavity on the left ventricle and the left auricle. The aneurysm is partly filled with blood, and the red muscle presents a uniform colour. The sac is partly filled with blood clot.
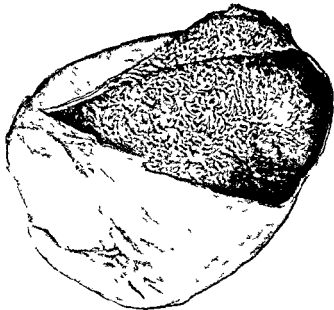
FIG 15.—Heart acute pericarditis ¾

Pericardial sac opened and turned aside, showing thick layer of fibrinous exudate covering heart villous appearance.

FIG 17 —Heart chronic interstitial
myocarditis ½

Apical portion of left ventricle showing white
patches of fibrous tissue replacing the muscle sub
stance The change is most marked at the apex and
in the right papillary muscle which has been cut
open

FIG 18 —Section through wall
of right ventricle showing in
crease of sub pericardial fat and
fatty infiltration of the muscle ½
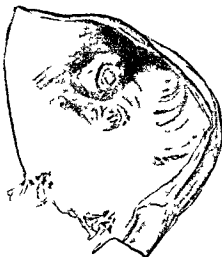
FIG 19 —Thrombus in right auricular appendix ¾
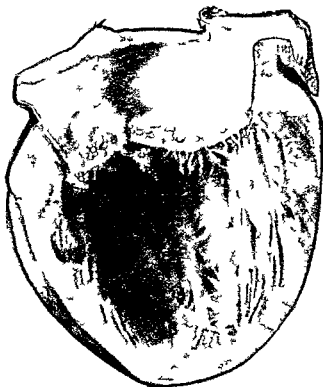
F G 20 —Heart of h d s mp e   ege a   e) endoca d
n a case of ho ea   ‡

3   ounded g a   g al e   se fre ma g

FIG 21 —Aortic valve simple endocard tis   ½

Vegetations along margin of two segments with red thrombus
attached to one of the vegetat ons.
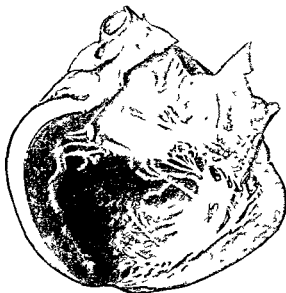
FIG. 22 —Heart ulcerative endocarditis of mitral valve   ½

The valve has been the seat of a previous endocard tis as evidenced by the
thickening of the segments and of the chordæ tend næ. Both sets of structures
are covered with vegeta ions which also extend on to the wall of the left aur cle
and chordæ tend næ. The wall of the left ventricle is thickened and the cav ty
dilated, due to the incompetence of the mitral valve which existed prev ous to the
ulcerative endocarditis. One or two of the chordæ tend næ have ruptured.
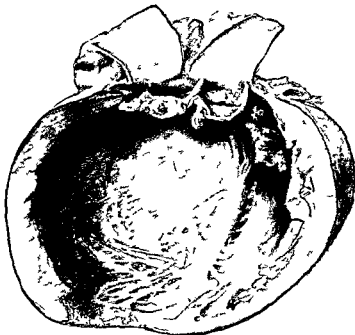
FIG 23 —Ulcerative endocarditis aortic valve   ½

The segments had been thickened previously   They are covered with vegetations.   One of the segments has ruptured   *There are also vegetations visible on the mitral valve to the right*   There is marked dilatation of the left ventricle largely due to the incompetence of the previously thickened valve.
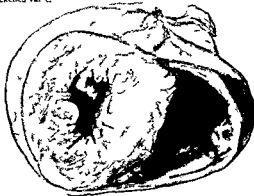
FIG 24 —*Transverse section of heart*   ½

Marked hypertrophy of left ventricle in case of chronic nephritis   Right ventricle dilated.
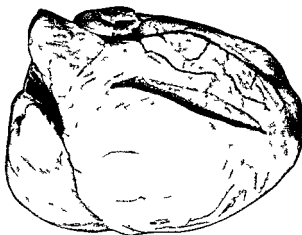
FIG 25

FIG 26

FIG 25.—Anterior aspect of heart from case of mitral stenosis showing dilatation of right ventricle and well marked hypertrophy as well as dilatation of right ventricle. $\frac{1}{2}$ The narrowed mitral valve.

FIG 26.—Same heart from behind showing dilatation of both ventricles. The narrowed mitral valve (button hole) can be seen. $\frac{1}{2}$

FIG 27 —Chronic endocarditis of aortic valve ¾

Calcareous deposits in the thickened cusps also union of the segments
with consequent stenosis.

FIG 28 —Portion of descending thoracic
aorta ½

Showing advanced atheroma.   Thrombi have
formed in one or two places.

FIG 29 —Arteries at base of brain ¾

Showing white patches of atheromatous change.
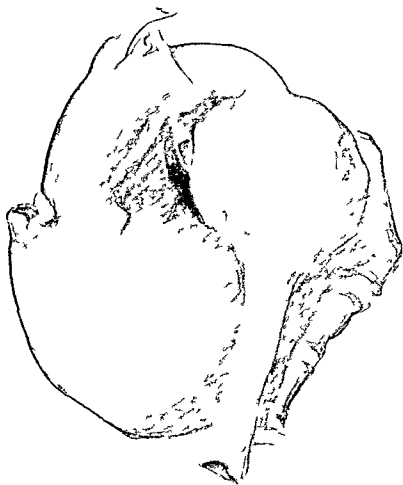
Fig 30 —Saccular aneurysm of descend g aorta adhe ent to and erod ng the bod es of the ertebræ ½

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FIG. 33.—Spleen, tuberculosis
necroses. (Museum of University
College, Dublin) ⅓

FIG. 32.—Spleen, myelogenous leukaemia ⅓
Opening readily into the pulp, the section is smeared
and one mother pulp, [fact]

FIG. 31.—Spleen considerably enlarged
from chronic. About is congested on ⅓
St[...] over and [...] at the aver[...] [...]
t[...] [...] [...] other [...] others, degrees at[...] and [...]
[...] traces of atrophy on

FIG. 34.—Spleen and spleniculus sago-av'y ½
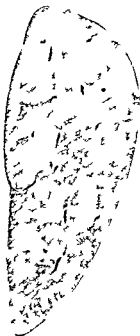
FIG. 35.—Spleen. Hodgkin's disease showing numerous scattered th.e masses a y ng n s e ½
The o gan con de al y enla ged.
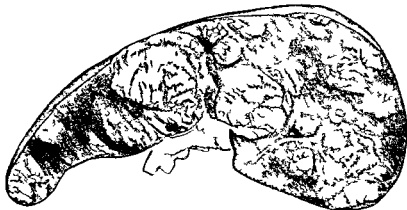
FIG. 36.—Spleen Hodgkin's disease (Dr Byrom Bramwell's case) ½
Sue ke a eas form ng large tumou ke masses.

FIG. 27.—Mass of tubercular lymphatic glands. In section showing numerous caseous foci.

FIG. 28 Inguinal glands implicated in carcinoma. The glands are shown (all tghenois vis se) dnenma

Ic 40 — I ung e phys   q   ⅜
Mo ma kei along n e or and lowe konie

I G 39   I'j o d ghnt ixopl 1a   c go re   ⅜
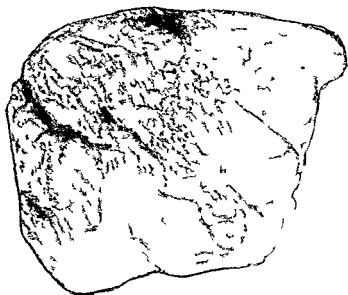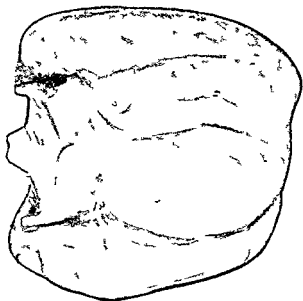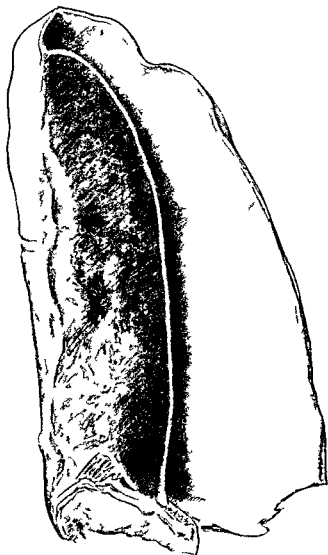
FIG. 41 —Lung collapsed to en pyema. $\frac{1}{2}$
The kening f pa   al and v scc al p eu a.

FIG. 42.—Lung lobar pneumonia. ½

The whole of the upper lobe and the upper portion of the lower lobe are consolidated and in the stage of grey hepatisation. The lower portion of the lower lobe is congested.
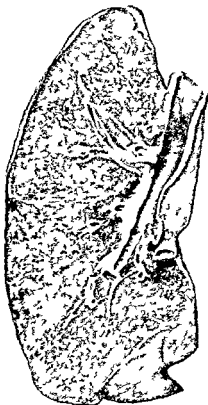
FIG 43 —Lung and bronch show ng acute bronch t s and sept c
broncho-pneumon a   ⅘

The b on h s n ed by the conge ed mucous membrane of the b oncl   he
b oncho-pneumon a by he defined pale a eas of conso ida on sca e ed th ough the
lung

FIG 46.—Lung gangrene. ¼

The dark areas in the centre are gangrenous cavities The pale zone around is due to pneumonia, consolidation

FIG 45.—Port on of lung showing two recent infarcts ½

(e) Infra t t projecting from branch of j ihn ry art pry artery

FIG 44.—False membranes in trachea in diphtheria. ¾

FIG 47.—Lung silicosis (Dr J D Comrie's collection.) ¼

Raised hard, grey areas, surrounded with black pigment, scattered in groups under pleura, around vessels and bronchi, and along interlobular septa.

Fig 50.—Mediastinal glands and lung of infant. ½
The former show marked enlargement due to tuberculous in the latter cases s (tuberculous) a broncho-pneumo n a

Fig 49.—Lung acute miliary tuberculosis. ½
Miliary tubercle s if cut, regularly s sectioned through it a lung

Fig 48.—Lung: infiltrous s ½
Note the uniform dark colour of the organ the ba wel areas of fibrous tissue forma on and pigment as while l b d olitic of pigmentation on the diaphragmatic face

FIG. 51 —Lung caseous (tuberculous) pneumonia with
cavitation ⅓

There is caseous consolidation of the upper portion, with numerous
acute cavities.   In the lower portion there are groups of tubercles
arranged in a staphyloid manner and casing lymphatic spread   The
pleura is thickened

Fig. 54.—Surface of lung acute pleurisy. ¼

Coagulation of vessels and thick fibrinous exudate
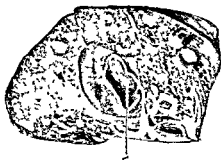
Fig. 52.—Lung chronic tuberculous with cavity in which an aneurysm (A) has formed ¼

The space between the aneurysm sac and the wall of the cavity is filled with blood clot. Fibrous tissue traversed throughout the lung
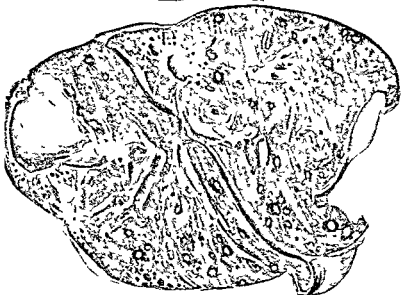
Fig. 53.—Lung fibro caseous tuberculosis with marked tendency to healing ½

Two chronic cavities are seen in apex of upper lobe, the other in apex of lower lobe, surrounded by fibrous tissue, and shows a tendency to contract and slip upon surrounding lung tissue causing creases on its surface. Note the deformity. Fibro caseous tubercle surrounded with tissues are scattered irregularly throughout the remainder of the organ

Fig. 55.—Section of lung showing large number of nodules of secondary carcinoma. ½

Fig. 56.—Lympho-sarcoma of the mediastinal glands invading the root of the lung. (Dr. Edwin Bramwell's case.) ⅓
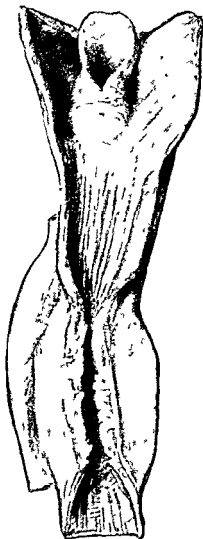
FIG 57 —Squamous epithelioma of œsophagus with marked narrowing of lumen ½
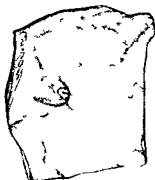
FIG 58 —Peptic ulcer of stomach with opening into vessel in floor of ulcer ½
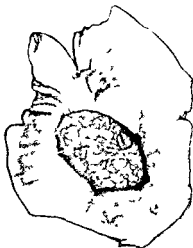
FIG 59 —Large duodenal ulcer (Dr Cattenach's case) ½

Pancreas forming floor Opening into large vessel at one point from which fatal hæmorrhage occurred
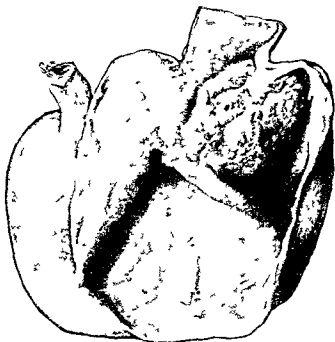
FIG. 60 —Stomach opened up anteriorly to display an epithelio I cancer close to card ac opening.
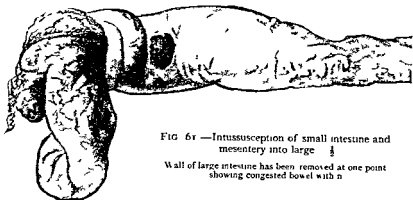
FIG 61 —Intussusception of small intestine and
mesentery into large ½

Wall of large intestine has been removed at one point
showing congested bowel with n

FIG 62 —Typhoid lesion of small
intestine ½

Early stage showing swelling of Peyer s
patch and solitary foll les.

FIG 63 —Typhoid lesion of small
intestine ½

Later stage with necrosis of swollen
patch and formation of slough.

FIG 64 —Tuberculous ulcer lower
portion of ileum ½

Note transverse d rect on ra sed margin
and irregular floor

FIG 65 —Tuberculous ulcer peri-
toneal aspe t showing ra sed tubercles
under peritoneum ½

FIG 66 —Large intestine ulcerative colitis (dysentery) ¼

Lines of hypertrophied mucous membrane with ulcerated surfaces between
in which the muscular coat is laid bare.
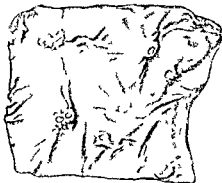
FIG. 67 —Portion of large bowel from case of amoebic dysentery
showing characteristic early lesion ¼

M note crater like ulcers with central slough
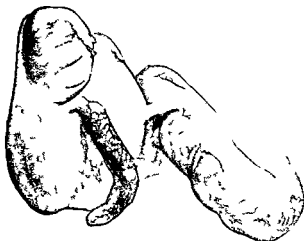
FIG 68 — Acute appendicitis and peritonitis. ½

The appendix is swollen and congested and has ruptured at two points.
The portion of small intestine seen is covered in part with a thick layer of
fibrinous exudate

FIG 69 —Pelvic colon with adeno carcinoma projecting into interior ¼

The wall of the gut is hypertrophied above

FIG 70 —Peritoneal aspect of loop of n e ne show g tuberculous pe o s. ⅔
There are a o we u g u he mesen ery from en ged mesen ne g d
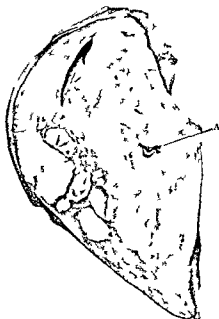
Fig 71 —Abscesses of l er port l py an a pe ⅔
A h ombus s en pro ec ng f m one of e b an hes of he port   n (↓).

FIG 72 —Liver large t optical abscess with much necrot e liver tissue ¼

FIG 73 —Liver of child showing multiple nodular hyperplasia (re generation of liver substance) follow ing an acute degenerative process (Dr Byrom Bramwell s case) ⅔
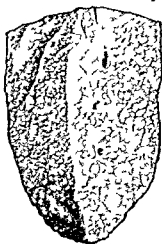
FIG 74 —Liver common cirrhosis. ½ Surface of organ shows bob-nail" projections. Sec tion shows areas of liver tissue varying in size separ ated from one another by bands of connective tissue.

Fig. 75.—Liver showing group of gummata. ⅔
Caseous foci surrounded by a zone of connective tissue.

Fig. 76.—Later cirrhous angioma. ¼

Fig. 77.—Section of the liver. 1 in.
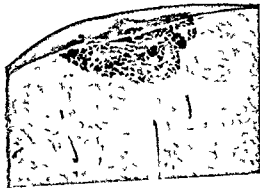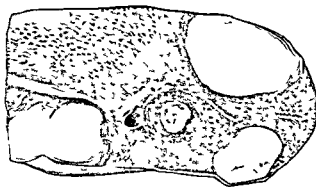
Fig 79.—Section of liver with hydatid cyst from which numerous smaller cysts are protruding. ⅓

Fig 78.—Liver, greatly enlarged with numerous secondary nodules of sarcoma. ⅓
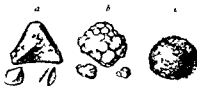
FIG 80 — Biliary calculi or gall stones

a common faceted type
b mulberry type
c rounded solitary stone composed of pure
cholesterin
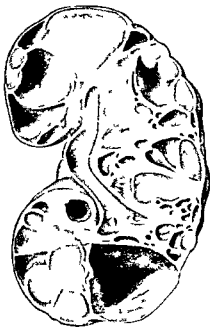
FIG 81 — Congenital cyst of kidney

Rounded spaces varying greatly in size some empty
others containing a translucent gelatinous material

FIG 82 — Infarcts of the kidney

Three infarcts varying in size are seen
in the upper part of the organ
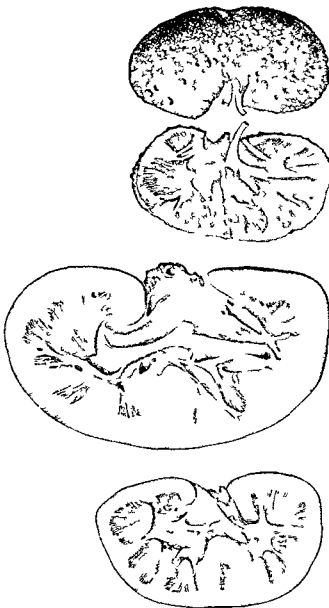
Fig 83.—Acute nephritis   Organ very slightly enlarged in rigid pallor and some swelling of cortex

Fig 84.—Subacute nephritis   Organ greatly enlarged   Cortex more especially hypertrophied   Cortex swollen and pale

Fig 85.—Chronic interstitial nephritis   Organ diminished in size   Section showing narrowed cortex

Fig 86.—The same surface viewed after stripping the capsule showing narrowing of surface and presence of subcapsular cysts

FIG 87.—Kidney pyæmic abscesses. ½
Cut surface.

FIG 88.—Kidney pyæmic abscesses. ½
Surface with capsule ripped.

FIG 89.—Kidney tuberculosis. ½
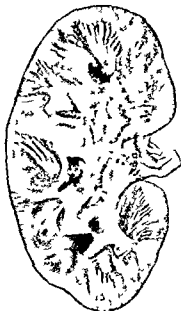
Acute type of the disease. Large masses of tuberculous tissue scattered mainly in groups, through organ. Primarily lined with zone of caseous tissue.

FIG 90.—Kidney tuberculosis. ½

Part at destruction of renal tissue forming caverns with ragged walls, and with a zone of caseous tissue around.

FIG. 91 —Kidney, hydronephrosis. ½
An S-shaped bend in the ureter following an injury

FIG. 92 —Kidney, hypɔnephroma and chronic venous congestion ⅓
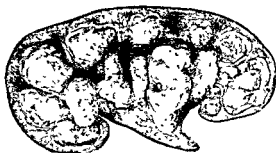
FIG. 93 —Coralline calculus in kidney. ½
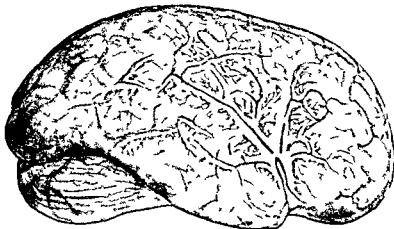
FIG 94 —Brain showing acute meningitis. ½

There is general prominence of the vessels and exudate in the sulci and fissures, especially the Sylvian fissure.
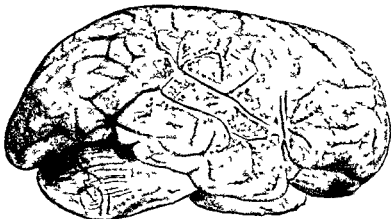
FIG 95 —Brain tuberculous meningitis. ½

Exudate extending up the Sylvian fissure and breaking up into discrete foci (tubercle ?) along the distribution of the smaller arteries in the sulci and over the convolutions.
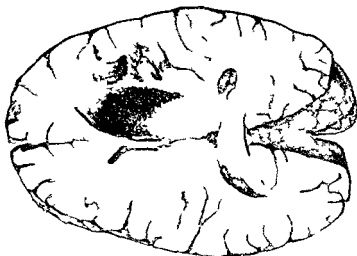
FIG 96—Section of brain showing rapid
hydrocephalus

I men on of a r en s eo da a bus men g

Fig 97 Section of brain showing internal hemorrhages into
left basal ganglia on right side

FIG. 98.—Cerebellum with depressed areas from softening of brain substance due to thrombosis in arteries. ½
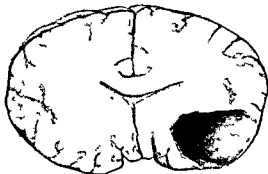
FIG. 99.—Vertical section of brain showing large solitary abscess in temporo spheno idal lobe. ½

FIG. 100.—Transverse section of pons showing hæmorrhages into its substance. ½

Fig. 103 — Scirrhous cancer of the breast with indrawing of nipple. ½

Fig. 102 — Portion (trimmed) of ovary containing sebaceous material. Solitary cyst above it (Dr W. J. Jordyce's case.) ½
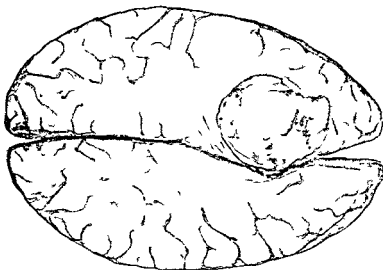
Fig. 101 — Cholesteatoma in frontal lobe (Sir Holburt Cushing's case.) ½
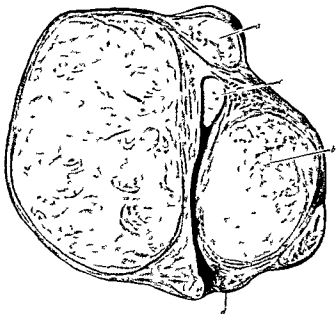
FIG. 104 — Myomata in wall of uterus. ½

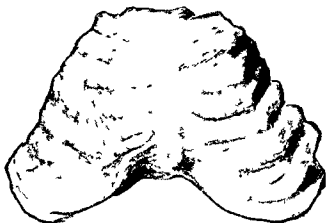a suberous type, b intramural type, c submucous type, d indicates position of os uteri.

FIG. 105 — Enlargement of costo-chondral junctions (rickety rosary) in rickets. ½

FIG 106 —Chronic osteomyelitis
of lower end of femur $\frac{1}{3}$

A new casing of bone is seen above,
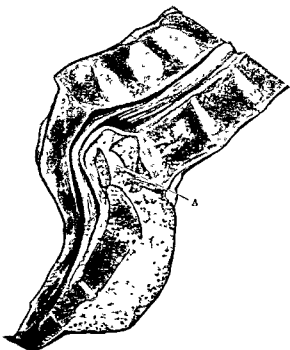below is necrosed bone with openings
(cloacæ)

FIG 107 —Lower lumbar vertebræ and sacrum
in section $\frac{1}{2}$.

Showing destruction of the body of one vertebra (A),
with abscess containing caseous material extending from
it anteriorly, the cauda equina being pressed upon behind
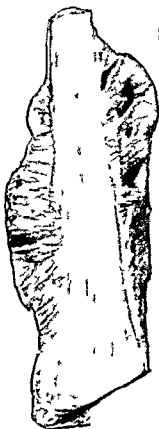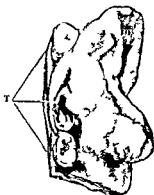The body of the vertebra above shows infiltration with
tuberculous foci.

FIG 109 —Myeloid sarcoma
of jaw ½

T indicates three teeth.

FIG 108 —Osteo-sarcoma of shaft
of femur ½